A longitudinal study of gambling in late adolescence and early adulthood: Follow-up assessment at 24 years

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Contents **Page**

EXECUTIVE SUMMARY

This report describes a longitudinal study of young peoples' gambling between 17 and 24 years, using a contemporary UK cohort, the Avon Longitudinal Study of Parents and Children (ALSPAC), known as Children of the Nineties. The aims of the ALSPAC Gambling Study were to describe gambling behaviour in young people aged 17-24 years, investigate the antecedents of regular and problem gambling, and explore the associations with other addictive behaviours and mental health.

When the children were aged 6 years in 1997-8, their parents completed the South Oaks Gambling Screen, and when aged 18 the mothers completed the Problem Gambling Severity Index (PGSI). Between 2008-2018, young adult participants in ALSPAC subsequently completed computer-administered gambling surveys in research clinics, on paper, and online. All young people still registered with the ALSPAC (n= 10,155) were invited to participate. The sample sizes completing the gambling surveys were 3757 at age 17 years, 4340 at 20 years, and 4345 at 24 years. Gambling frequency questions and the PGSI were asked at each age. Depression, anxiety and wellbeing scores, and drug and alcohol usage, were collected by self-completion questionnaires.

Participation in gambling in the past year was reported by 54% of 17-year-olds, rising to 68% at 20 years, and 66% at 24 years, with little overall variance. The most common forms of gambling were playing scratchcards, playing the lottery, and private betting with friends. The only activity which increased markedly between 17 and 24 years was gambling on activities via the internet, especially among males. At 24 years, nearly 50% of all gambling activities in males were carried out online compared to 11% for females.

Regular (weekly) gambling showed a strong male gender bias, increasing from 13% at 17 years to 17% at 24 years. Regular gamblers were more likely to have a low IQ, an external locus of control, and high scores on a sensation seeking scale. They were more likely to smoke, abuse alcohol, and to use social media than non-gamblers. Family factors associated with regular gambling included having younger mothers with low education levels, mothers who struggled financially, and parents who gambled regularly.

Problem gambling was assessed at each age using the PGSI, and responses categorised into 'low risk gambling' (16-21%) and 'moderate risk/problem gambling' (4-6%). Any at-risk gambling was associated with previous frequent playing of video games and less parental supervision, and higher scores on hyperactivity and sensation seeking, an external locus of control, depression and lower mental well-being. Following adjustment, moderate risk and problem gamblers at the age of 24 were shown to be regular gamblers, who were more likely to have problematic use of alcohol and drugs and to be involved in criminal activity.

Problem gamblers were more likely to have parents who had problems with gambling, and to come from families with previous financial difficulties.

In conclusion, although many young people gamble without any harm, a significant minority (mainly males) show problem gambling behaviours which are associated with poor mental health and wellbeing, involvement in crime, and potentially harmful use of drugs and alcohol. Many young people had tried different forms of gambling between 17 and 24 years, but the only activity showing a consistent increase over this age range was online gambling and betting. Patterns of problem/moderate risk gambling were set by the age of 20 years.

INTRODUCTION

Young people are known to be at risk of problems with gambling because of cognitive immaturities and lack of development of executive function which increase risk-taking behaviours. This vulnerability may increase given the expanding opportunities for young people to gamble through online gaming, fixed odds terminals, and in-play betting. Consequently, more information is needed about how problem gambling evolves in young people so gambling-related harm can be prevented. However, there is little detailed research on the development of gambling behaviour during the phase between late adolescence and young adulthood, when problem gambling often begins. This research used a contemporary follow-up study in the UK called the Avon Longitudinal Study of Parents and Children (ALSPAC) to examine gambling behaviour and problem gambling in the 17-24 year age group.

A previous report to the Responsible Gambling Fund in 2011 detailed our findings of gambling behaviour in adolescents aged 17 years (Emond et al., 2011). A separate study funded by Gamble Aware (Forrest & McHale 2018) reported the influence of parental gambling on young people's gambling experience at 17 and 20 years. This report covers the third phase of data collection at 24 years, and the analyses which have been undertaken on self-reported gambling data from the three sweeps of the cohort, at 17, 20, and 24 years.

BACKGROUND

According to the Health Survey for England 2018 (NHS Digital 2019), 53% of adults aged 16 years and over reported gambling in the last year in 2018. Many people gamble occasionally without any problem, but regular gambling can sometimes escalate to problematic levels characterised by persistent and recurrent maladaptive behaviour that leads to personal and social harm (e.g., financial difficulties, low mood, family breakdown; Hodgins et al., 2011). Although rates of gambling disorders are currently around 0.5% in England, there are higher

prevalence rates of 'at-risk' gambling- defined by experiences of at least some adverse consequences from gambling (around 3% of men: NHS Digital 2019). There are concerns that these levels could increase along with growth in gambling opportunities through electronic gaming machines (EGMs) (e.g., fixed odds betting terminals; Blaszczynski, 2013) and the expansion of online gambling services (Griffiths, 2003).

Overall estimates of gambling problems mask considerable socio-demographic variability, and elevated risk among young adults. The HSE18 showed around 2% overall and 3.8% of males aged 16-24 years in England reported at least some problems with gambling (NHS Digital 2019). The findings are consistent with other studies suggesting rates of gambling problems among youth that are 2-4 times higher relative to older cohorts (for a recent systematic review on adolescent gambling see Calado, Alexandre & Griffiths, 2017). These levels may be attributed to multiple factors, including underdeveloped neurobiological systems and associated proclivities towards multiple impulsive and high risk behaviours (Chambers & Potenza, 2003); and vulnerabilities to cognitive biases (e.g., illusions of control over outcomes) and poor statistical knowledge (Delfabbro et al., 2006). Young people may also have heightened susceptibility to environmental factors that can determine gambling, including family and peer influences (Langhinrichsen-Rohling et al., 2004), and messages from marketing campaigns that distort the social and financial rewards from gambling (Derevensky et al., 2010).

There is evidence of adverse consequences of excessive gambling for young people, which include negative emotional states, poor educational and vocational outcomes, and difficulties in family or peer relationships (Hardoon et al., 2004). Most of this evidence comes from cross-sectional study designs, with few prospective studies of long-term consequences in adolescence (11-17 years) and across the transition to adulthood (18-25 years). Relevant studies which are available have reported mixed findings. For example, Dussault et al. (2011) analysed data from 1004 males from 17 to 23 years and found that depression and gambling problems were reciprocally linked. That is, problem gambling in adolescence was associated with increased depression in adulthood, while depression was also associated with increased problem gambling. In contrast, Vitaro et al. (2008) evaluated data from a smaller sample and found that gambling problems at 16 years were not related to depression at 23 years. Few other studies have examined problem gambling among adolescents and long-term implications in adulthood. Longitudinal studies which have followed adolescents across the transition to adulthood include investigations in Canada (Vitaro et al. 2008), Australia (Delfabbro et al., 2014; Scholes-Balog et al., 2014), and the U.S. (Barnes et al., 2005; Liu et al., 2014; Slutske et al., 2005; Winters et al., 2002). Some of these studies (e.g., Delfabbro et

al., 2014; Winters et al., 2002) have addressed specific questions relating to stability or change in gambling and problem gambling across adolescence and early adulthood. These studies have suggested that: (i) rates of gambling increase gradually with age, and particularly from adolescence to adulthood (when commercial gambling becomes legal; (ii) these changes may be heterogeneous, with levels increasing for some activities (e.g., EGMs) while decreasing for others (e.g., card games; Winters et al., 2002); and (iii) although prior gambling is predictive of subsequent behaviour, there is considerable within-person inconsistency, such that preferences for different types of games are highly variable from one year to the next (Delfabbro et al., 2014). The literature is characterised by small samples and few participants reporting gambling-related problems, which limits what can be said about stability in gambling problems during the transition to adulthood. These studies are also poorly equipped to address questions regarding young people's gambling behaviour and long-term consequences in terms of risk for gambling problems or addiction disorders in adulthood.

Additional studies have considered the developmental antecedents of problem gambling. The current evidence on such antecedents relates mainly to dispositional factors, and family influences. Evidence from long-term studies indicates that temperament observed as early as 3-years old may relate to gambling problems in adulthood (Slutske et al., 2012). There are several studies which suggest that impulsivity in adolescence is predictive of problem gambling in early adulthood (e.g., Dussault et al., 2011; Liu et al., 2014). Studies of family influences have suggested that low levels of parental monitoring in adolescence may predict gambling problems in adulthood (Lee et al., 2014), which may also relate to variables including parental gambling (Winters et al., 2002) and family rewards for pro-social behaviour (Scholes-Balog et al., 2014). However, these studies are few in number and are yet to consider many factors in adolescence (e.g., parental problem gambling) that may impact on the development of gambling problems in adulthood.

The available literature demonstrates a clear need for new prospective studies that are better able to: (i) evaluate the stability in gambling problems across early adulthood, and examine youth gambling over time to evaluate the risk of subsequent gambling disorders; (ii) explore the long-term consequences of problem gambling in adolescence for a range of relevant outcomes (e.g., depression, substance use problems, psychosocial adjustment) in early adulthood; and (iii) examine a wider range of variables in childhood and adolescence that may function as developmental antecedents of gambling problems in early adulthood. The Avon Longitudinal Study of Parents and Children (ALSPAC) is a contemporaneous British cohort study which provides an excellent opportunity to prospectively investigate changes in gambling from adolescence to early adulthood.

The ALSPAC GAMBLING STUDY

The cohort

ALSPAC, known as Children of the Nineties, is a multi-generational prospective study of health and development across the life span. It commenced in 1991-92 with recruitment of around 14,000 pregnant women who were resident in the South West of England (Boyd et al., 2013). These women, their partners, and their children have been followed regularly since this time, and have provided information across more than 70 data collection points over a 25-year period. Sources of data include birth, medical, and educational records child-completed questionnaires, clinic assessments, and questionnaires completed by the mother or main caregiver. Data from teachers have also been obtained, while data linkage projects have been conducted. There is a core sub-sample of over 3000 families that have responded to all assessments, and 5,777 that have responded to 75% or more of these assessments.

The study website contains details of all the data that are available through a fully searchable data dictionary (http://www.bris.ac.uk/alspac/researchers/data-access/datadictionary/). Ethical approval for the ALSPAC was obtained from local research ethics committees, and the ALSPAC Gambling Study was overseen by the ALSPAC Ethics and Law Committee. The questions used in the ALSPAC Gambling Study were approved by the cohort user group – the ALSPAC Young People's Advisory Group (YPAG) – and all participants in the gambling study gave individual consent to be included in the research.

Overall aims of the ALSPAC Gambling Study

The main aims of the ALSPAC Gambling Study were to describe young people's gambling behaviour and attitudes using a contemporary UK cohort, and to investigate the antecedents and consequences of at-risk and problem gambling in young adulthood based on factors identified in previous major reviews in the area.

Specific objectives

(1) To describe the natural history of gambling behaviour from 17 to 24 years;

(2) To investigate trajectories of development of gambling problems from 17 to 24 years;

(3) To explore the implications of youth gambling for risk of gambling problems at 24 years;

(4) To describe the associations of gambling problems with mental health and wellbeing in early adulthood;

(5) To identify developmental factors (e.g., individual characteristics, family influences) associated with gambling problems in early adulthood.

Gambling data available

When the children were aged 6 years in 1997-8,both their parents completed the South Oaks Gambling Screen, and when aged 18 in 2010-11 the mothers completed the Problem Gambling Severity Index. The young participants were asked about gambling behaviour and attitudes, and completed the Problem Gambling Severity Index, at 17 years-old in 2008-10 (n=3757), at 20 years-old in 2012-13 (n= 4340) and at 24 years-old in 2017-18 (n=4345). This report summarises the data collected in all three sweeps of the young participants.

METHODS

1. Measures used and data collection

Data were collected at (i) 17 years by a computerized questionnaire in clinic and an online questionnaire; and (ii) 20 and 24 years by online questionnaire and postal questionnaire. Responses on paper questionnaires were keyed in by ALSPAC staff onto the database.

Gambling activity

Participation in gambling during the past year was assessed at all three time points using items derived from the British Gambling Prevalence Survey 2007 (Wardle et al., 2008). For the analyses, 13 common items for all ages were used (Table 1). The response options at all ages were collapsed to 0 ("no gambling within the past 12 months"), 1 ("less than weekly gambling within the past 12 months), and 2 ("weekly gambling or more within the past 12 months"). Only participants who answered all 13 items were used (97% of all respondents).

Those who answered *no gambling within the past 12 months* on all 13 questions were classified as non-gamblers. Participants answering weekly or more frequently on at least one of the 13 items were classified as *regular gamblers* and the remaining participants were thereafter classified as *occasional gamblers*. The sample sizes used for analyses were 3566 at 17 years, 3940 at 20 years, and 3841 at 25 years.

Table 1. Gambling activities included in the surveys at age 17, 20 and 24 years

Activity	Includes	Excludes
Lottery games	*Lotto, Thunderball* and *Euromillions*	Scratchcards
Scratchcards	Lottery scratchcard games played offline and online	Newspaper or magazine scratchcards
Football pools	-	Betting on football matches with a bookmaker
Bingo cards or tickets	Playing boards at a bingo hall	Newspaper bingo tickets, or bingo played online
Gaming machines	Fruit machines, slot machines	Quiz machines
Virtual gaming machines	Betting on virtual roulette, keno, bingo etc. in a bookmaker's	Quiz machines
Table games	Roulette, dice, poker, or cards in a casino	Poker or casino games played online
Online gambling	Playing poker, bingo, slot machine style games, or casino games for money online through a computer, mobile phone or interactive television	Bets made with online bookmakers or betting exchanges
Online betting with a bookmaker	Betting online through a computer, mobile phone or interactive TV on any event or sport	Bets made with a bad-betting exchange or spr
Betting on horse races	Betting on horse races with a bookmaker, by phone, or at the track. Also includes tote betting and betting on virtual horse races shown in a bookmaker's	Bets made with online or bookmakers betting exchanges.
Betting on sport	Betting on any other event than horse or dog races or sport at the bookmakers, by phone or at the venue. Also includes Irish Lottery, 49s	Bets made with online bookmakers or betting exchanges or spread-betting.
Spread betting	In spread betting individuals bet that the outcome of an event will be higher or lower than the bookmaker's prediction. The amount won or lost depends on how right or wrong the betting prediction was.	
Private betting	Playing cards or games for money with friends, family or colleagues	-

Antecedents of gambling

The choice of antecedents was informed by previous analyses and reviews of the gambling literature (e.g., Griffiths, 2002, 2011), and were clustered into child, parental, and socioeconomic factors. Child variables included: gender, IQ at age 8 years (lowest quartile <90), computer gaming at age 13-14 years, hyperactivity and conduct problems at age 16.5 years, locus of control at age 16.5 years, sensation seeking at age 17 years, stressful life events at age 16 years, education/employment status at age 17 and 20 years, diagnosed depression at age 17 years, self-reported smoking and alcohol use at age 16.5, 21 and 23 years, and social media use at age 24 years. Parental variables included: maternal age at birth, maternal highest education level in pregnancy, maternal gambling when child was aged 6 and 18 years, paternal gambling when child was aged 6 years, and maternal and paternal depression when child was aged 10-12 years. Socioeconomic (hereafter SES) variables included: crowding index in pregnancy, financial difficulties in pregnancy, index of multiple deprivation (IMD) when child was aged 11 years, and housing status when child was aged 18 years. More detailed information about variables used is provided in the appendix in Supplementary Material 1.

Problem gambling

The Problem Gambling Severity Index (PGSI) is a 9-item scale derived from a 31-item larger screen, the Canadian Problem Gambling Inventory (Ferris and Wynne 2001). The PGSI is a well-validated test which has been widely used in international prevalence studies, including the two most recent British Gambling Prevalence Surveys in 2007 and 2010 (Wardle et al., 2008; 2011). The PGSI items each have four response options. For each item, “sometimes" is given a score of 1, “most of the time" scores 2, and “almost always" scores 3. Respondents to the PGSI were categorised as: non-problem gamblers (score of 0), low-risk problem gamblers with few or no identified negative consequences (score 1 or 2), moderate-risk problem gamblers leading to some negative consequences (score 3 to 7), and problem gamblers with negative consequences and possible loss of control (score 8 or more). Only those participants that gamble answer the PGSI questions. Due to low numbers, moderate risk problem gamblers were pooled with problem gamblers for analyses, as has been done in many previous studies (e.g., Canale et al., 2017a, b; Potenza et al., 2011; Wickwire et al., 2007).

Outcomes used for investigating effect of problem gambling on mental health and other maladjustments in young adulthood were: depression, anxiety, self-harm, criminal activity, use of illicit drugs, cannabis, smoking cigarettes, alcohol disorder, employment, and independent living. All outcomes were measured when participants were aged 24 years. More detailed information about these outcome variables is provided in Supplementary Material 1.

2. Analytic plan and statistical methods

The statistical analyses underwent several stages. Given the nature of these longitudinal gambling data, we began by examining all available data using *trajectory analysis* methods. Based on expert advice and polychoric correlations, the 13 gambling behaviours were first collapsed into six categories. These categories were then entered into latent class analysis. Model fit was assessed using well established criteria such as sample-size adjusted Bayesian Information Criterion, Bootstrap Likelihood Ratio Test (BLRT) and Lo-Mendell-Rubin (LMR) test statistics (Nylund et al., 2007). After several attempts with different model specifications, we concluded that using this method resulted in overall poor statistical fit, that gambling behaviours were not separable in any sensible way, and there were inconsistent changes over time.

We therefore moved on to utilizing *growth mixture modelling*. To do so, we summed the 0 (no gambling), 1 (<weekly gambling), and 2 (weekly gambling) scores across the 13 behaviours to create a continuous score ranging from 0 to 26. Because the data were severely positively skewed due to the excess of individuals scoring 0, we tried several different models including a (i) Poisson model; (ii) Zero-Inflated Poisson model; (iii) Negative Binomial model; and (iv) Zero-Inflated Negative Binomial model with various model specifications. Again, the statistical fit was very poor and there was a complete lack of heterogeneity over time, showing that each time point behaved very similarly to the others, particularly the latter two (20 and 24 years). Such a complicated modelling approach is therefore of limited use.

Considering this, we decided to analyse these data using traditional *regression methods*. Each time point was analysed separately bearing in mind that some individuals were repeated across time; however, there was also a substantial influx of new participants across time. Univariate tests included Chi-square tests, and ANOVAs. Multinomial or binary logistic regressions were used when adjusting for other variables and results presented as odds ratios with 95% confidence intervals.

Missing data

Of the 10,155 who were invited to the ALSPAC 17+ clinic, 4554 young people attended clinic. Of these, 2824 completed the gambling questions in the computer session in clinic, and a further 933 completed the questionnaire online. Most of those who attended but did not complete the gambling station had started the gambling questionnaire but abandoned it before the end. Overall, at age 17 years, 82% of those attending the research clinic completed the gambling questionnaire. At 20 and 24 years, the questionnaire was only available online (with a back-up option of a postal questionnaire) and the completion rate was reduced to 47%.

Participants lost to follow-up were more likely to be male, to have hyperactivity and conduct problems, have a higher sensation seeking score, be unemployed/not in education, smoke and drink alcohol weekly, have mothers with low educational qualification, more financial difficulties, and who gambled regularly when the child was aged 6 years. Amongst those that returned the questionnaires, up to 40% had missing data on the variables of interest. It is likely that without taking this into account, the results would be biased. This was corrected for by using Multiple Imputation, which is a common technique used to correct for bias introduced by missing data (Sterne et al., 2009). We imputed up to the number of participants who had answered at least one of the three gambling questionnaires (N=5981) using 50-100 imputations depending on the amount of missing data. Using the imputed data sets, adjustment for other variables was carried out in a stepwise procedure: (i) unadjusted models, (ii) adjusted for all child variables, (iii) adjusted for child variables and parental variables, and (iv) adjusted for child variables, parental variables, and SES variables. The univariable (unadjusted) results are presented as supplementary tables in the Appendix, and the multivariable models (fully adjusted) are embedded in the text of the report.

RESULTS

More females than males completed the gambling surveys at each time point: 58% females at age 17 years, 61% females at age 20 years, and 65% females at age 24 years. Overall, 37% of those invited completed the gambling survey at 17 years compared to about 47% for 20 and 24 years.

Any gambling

Participation in any gambling in the past year was reported by 54% of 17-year-olds, rising to 68% at 20 years, and 66% at 24 years. Males were more likely to report any gambling than females at all 3 ages (table 2). The most common forms of gambling were: playing scratchcards, playing the lottery, and private betting with friends (Figure 1). Betting and gambling via online sources increased markedly between 17 and 24 years (Figure 1). Some activities showed an increase followed by a decrease, suggesting experimentation with access followed by adaptation (e.g., virtual gaming, football pools). Some increased and stayed relatively constant (e.g., sports betting, bingo, spread betting). Perhaps unsurprisingly, participation in activities that are illegal before age 18 years such as gambling at racetracks, bingo halls, and casinos, increased from 17 to 20 years but remained relatively constant between age 20 and 24 years (Figure 1).

Figure 1. Percentage of participants engaging in any of the 13 gambling behaviours in the past 12 months for all ages (17, 20, and 24 years).

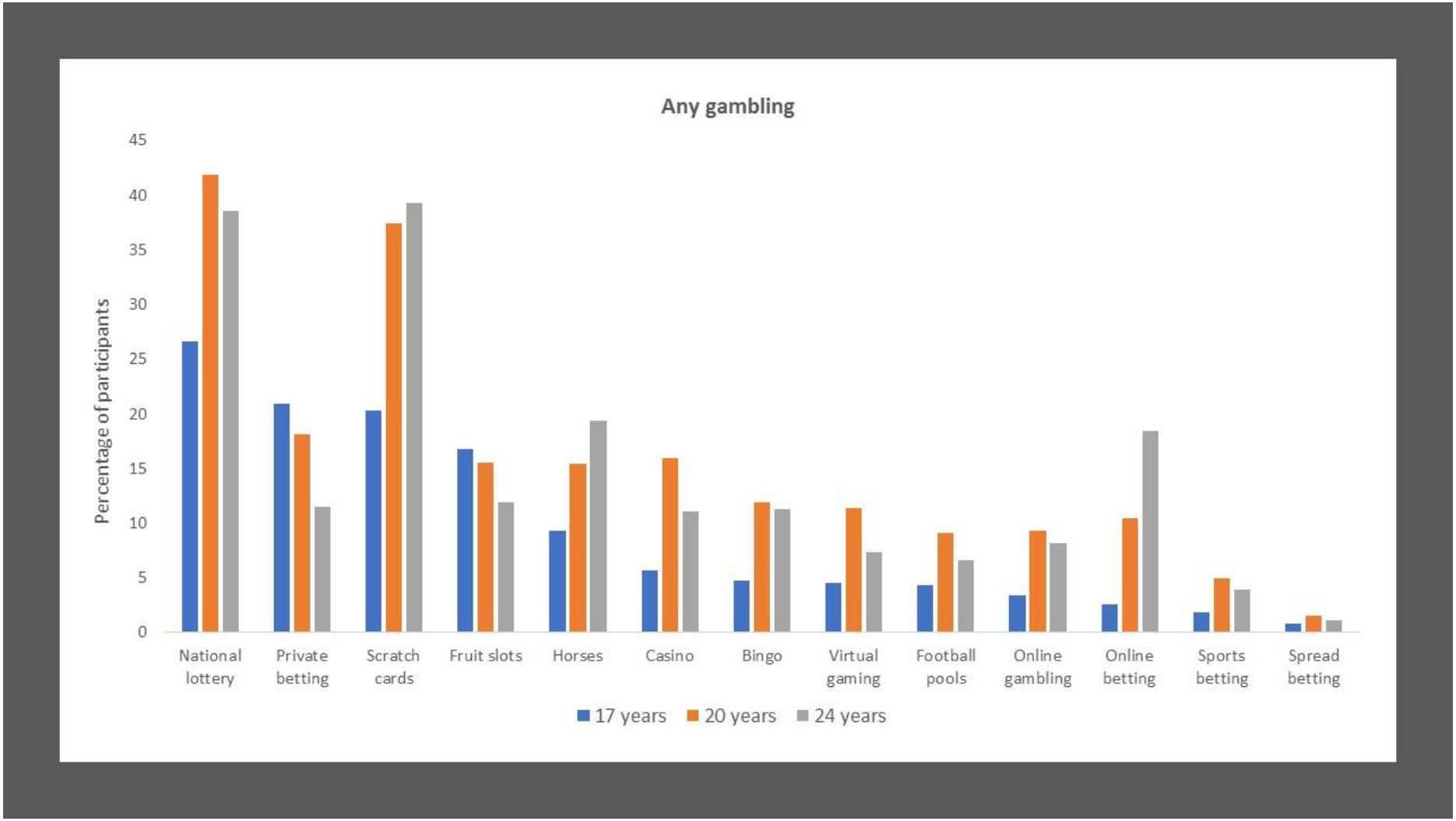

Table 2. Distribution of non-gamblers, occasional gamblers, and regular gamblers by sex.

	No gambling	Any gambling	
		Occasional (<weekly) Gamblers	**Regular** (>= weekly) Gamblers
17 years			
Males (N=1505)	588 (39.1%)	715 (47.5%)	202 (13.4%)
Females (N=2061)	1044 (50.7%)	897 (43.5%)	120 (5.8%)
Total (N=3566)	1632 (45.8%)	1612 (45.2%)	322 (9.0%)
20 years			
Males (N=1555)	401 (25.8%)	868 (55.8%)	286 (18.4%)
Females (N=2385)	858 (36.0%)	1332 (55.8%)	195 (8.2%)
Total (N=3940)	1259 (32.0%)	2200 (55.8%)	481 (12.2%)
24 years			
Males (N=1362)	388 (28.5%)	740 (54.3%)	234 (17.2%)
Females (N=2479)	904 (36.5%)	1380 (55.7%)	195 (7.9%)
Total (N=3841)	1292 (33.6%)	2120 (55.2%)	429 (11.2%)

The individual characteristics associated with any gambling at 17, 20, and 24 years are contained in supplementary tables 2-4.

Regular gambling

Participants who reported engaging in some form of gambling at least weekly increased from 9% at 17 years to 12.2% at 20 years, and reduced slightly to 11.2% at 24 years. A similar pattern was seen in both males and females (Table 2), but overall regular gambling showed a strong male gender bias, increasing from 13% at 17 years to 17% at 24 years. The increase in females was 6% at 17 years to 8% at 24 years. The most common form of gambling reported amongst male and female regular gamblers at age 17 years were playing scratchcards and lottery games, but more so in females than males (Figure 2). Private betting, football pools, slot machines, and online gambling were relatively common in males but less so in females. Females played more bingo than males (Figure 2). Online betting increased substantially in both males and females from 17 to 24 years, but this increase was much more apparent in males. At 24 years, nearly 50% of all gambling activities constituted online betting among males compared to 11% for females (Figure 2).

Associations with regular gambling

At all ages, regular gamblers were more likely to have a lower IQ, smoke and drink alcohol regularly, and be out of employment/education. (The univariable associations are contained

in Supplementary Tables 2-4). Only IQ, smoking, and alcohol use remained associated after adjustment. Table 3 shows the fully adjusted model for males, and Table 4 the model for females. Regular gambling was associated with a childhood history of hyperactivity and conduct problems, and playing videogames with friends at 13/14 years. Regular gamblers had high scores on the Arnett Sensation-Seeking Scale and were more likely to have an external locus of control. Only locus of control and sensation seeking associations remained after adjustment. At age 24 years, regular gamblers were more likely to be regular users of social media. Participants who had younger mothers, mothers with low education level, mothers who struggle financially, and parents who gamble regularly, were more likely to participate in regular gambling. Females (Table 4) who gambled regularly differed from males (Table 3) in that no association was found with low IQ or high sensation seeking scores, but an association was apparent with socio-economic status (living in social housing at 18 years).

Figure 2. Gambling activities undertaken by **regular gamblers** amongst males and females at all three ages. Asterisks denote significant differences in proportions (Z-test, $p<0.05$) between males and females.

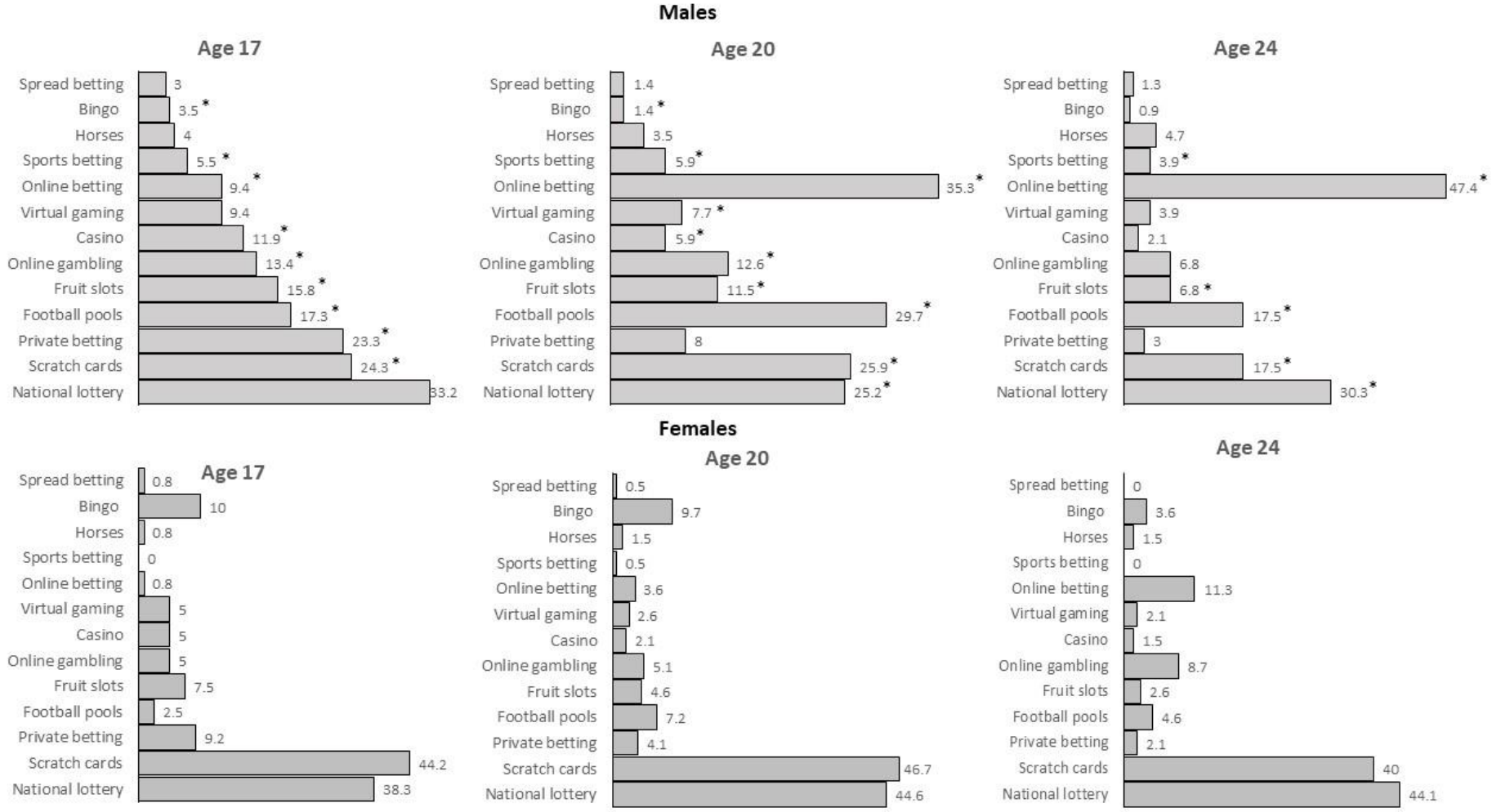

Table 3. Summary table of fully adjusted multinomial odds ratios for regular (weekly) gambling in *males* at each of the three time points

Only those significant after full adjustment at one or more time points are shown. The sections with diagonal lines represent non-significant results and shaded sections represent variables not measured at that age. Odds ratios highlighted in bold represent significant results. Description of variables are provided in Supplementary Table 1.

	Males		
Variable	Age 17 years	Age 20 years	Age 24 years
IQ at 8 yrs.			
- bottom quartile (<90)	**2.01 (1.27, 3.17)**	**1.82 (1.14, 2.91)**	
Locus of control at 16.5 years			
- >median [external]	**2.00 (1.40, 2.85)**		
Sensation seeking at 17 years	**1.03 (1.00, 1.07)**	**1.04 (1.01, 1.07)**	
Smoking cigarettes at 16.5 years			
- tried	**1.86 (1.16, 2.96)**		
- <weekly	2.15 (0.97, 4.76)		
- ≥ weekly	**2.57 (1.41, 4.67)**		
Smoking cigarettes at 20 years			
- ≥ weekly	**1.71 (1.11, 2.62)**		
Alcohol use at 20 years			
- hazardous	**2.33 (1.65, 3.31)**		
- harmful	**5.33 (3.08, 9.22)**		
Smoking cigarettes at 23 years			
- ≥ weekly	**2.37 (1.49, 3.78)**		
Social media use at 24 years			
-2-10 times/day			**1.80 (1.07, 3.02)**
- >10 times/day	**3.05 (1.78, 5.21)**		
Maternal education			
- degree higher than A level	**0.27 (0.14, 0.53)**	**0.34 (0.17, 0.68)**	**0.38 (0.20, 0.74)**
Maternal gambling child age 6 years			
- <weekly	**1.88 (1.20, 2.93)**	**1.78 (1.11, 2.86)**	
- ≥ weekly	**2.06 (1.31, 3.26)**	**2.58 (1.70, 3.91)**	
Paternal gambling child age 6 years			
- < weekly	1.53 (0.84, 2.81)	**1.67 (1.00, 2.78)**	1.59 (0.95, 2.66)
- ≥ weekly	**2.19 (1.12, 4.29)**	**2.23 (1.25, 3.98)**	**1.84 (1.09, 3.10)**
Maternal gambling child age 18 years	**1.51 (1.01, 2.26)**		
- no problem gambler	1.74 (0.60, 5.10)		
- low-high risk gambler			

Table 4. Summary table of fully adjusted multinomial odds ratios for regular (weekly) gambling in *females* at each of the three time points

Only those significant after full adjustment at one or more time points are shown. The sections with diagonal lines represent non-significant results and shaded sections represent variables not measured at that age. Odds ratios highlighted in bold represent significant results. Description of variables are provided in Supplementary Table 1.

	Females		
Variable	Age 17 years	Age 20 years	Age 24 years
Locus of control at 16.5 years			
- >median [external] **1.82 (1.17, 2.82)**			
Smoking cigarettes at 16.5 years			
- tried 1.57 (0.98, 2.54)			
- <weekly 1.64 (0.73, 3.69)			
- ≥ weekly **3.36 (1.97, 5.71)**			
Smoking cigarettes at 20 years			
- ≥ weekly **1.99 (1.35, 2.95)**			
Alcohol use at 20 years			
- hazardous **1.52 (1.05, 2.20)**			
- harmful **1.80 (1.01, 3.22)**			
Smoking cigarettes at 23 years			
- ≥ weekly **2.51 (1.58, 4.00)**			
Social media use at 24 years			
-2-10 times/day			1.92 (0.89, 4.13)
- >10 times/day **2.80 (1.29, 6.09)**			
Maternal education			
- degree higher than A level **0.15 (0.05, 0.47)**	**0.18 (0.08, 0.40)**	**0.37 (0.18, 0.77)**	
Maternal gambling child age 6 years			
- <weekly 1.51 (0.90, 2.52)			
- ≥ weekly **2.43 (1.50, 3.93)**			
Paternal gambling child age 6 years			
- < weekly 1.33 (0.75, 2.36)			
- ≥ weekly **2.23 (1.20, 4.12)**			
Housing child age 18 years			
- council/housing association **2.60 (1.31, 5.14)**			

The associations between occasional and regular gambling between 17 and 24 years are illustrated in Figure 3, which contains the odds ratios for the flow between different categories of gambling frequency at different ages. Although some occasional gamblers at 17 years did become regular gamblers by 24 years, the strongest associations are seen for regular gambling from 17 to 24 years.

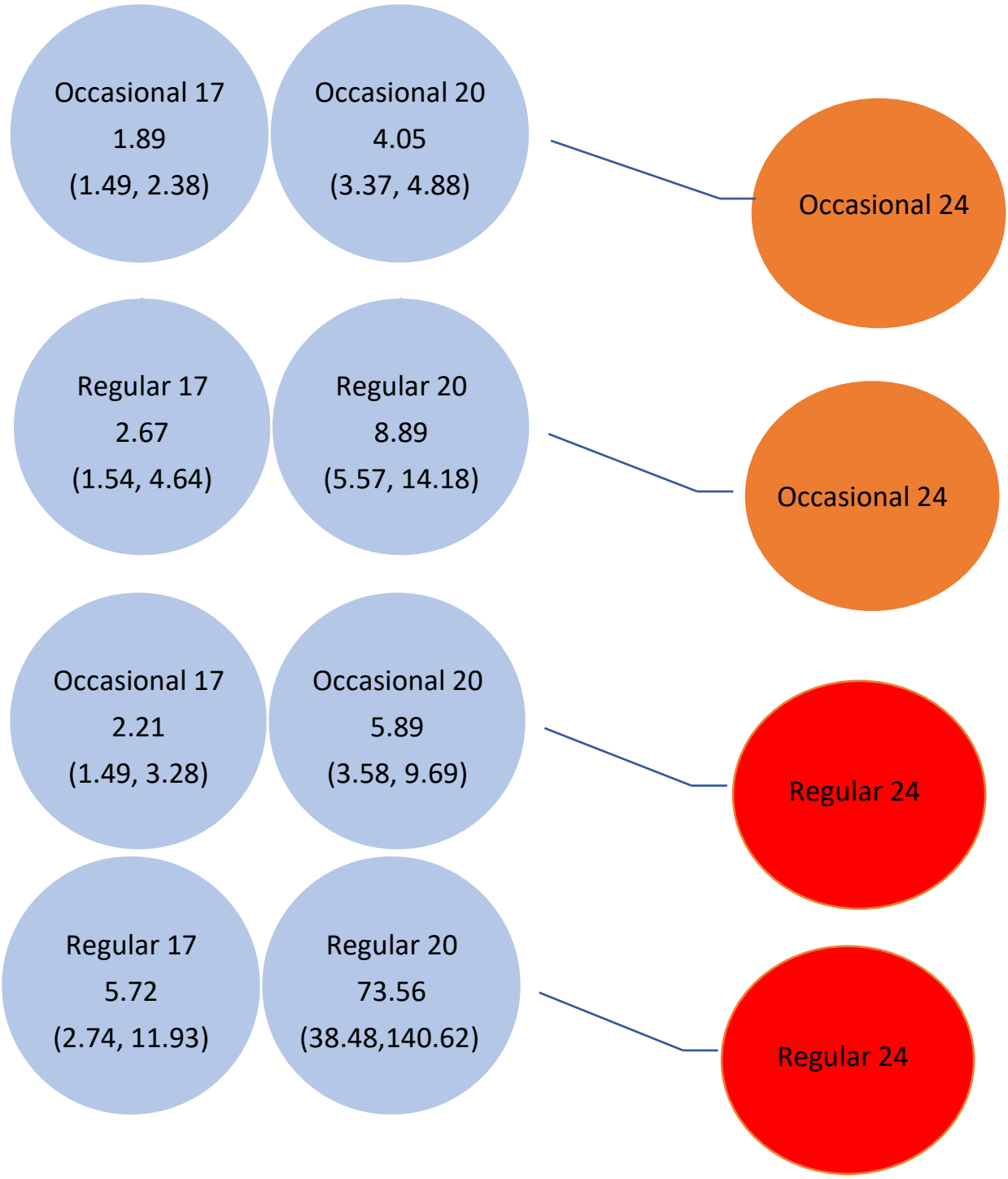

Figure 3. Odds ratios (95%CI) of associations between occasional and regular gambling between 17 and 24 years

At-risk/problem gambling

Between 60-90% of those that reported gambling activity answered the PGSI questions. The proportion of gamblers with a score of 8 or above on the PGSI was low at age 17 (0.7%) but doubled to 1.5% between age 17 and 24 years (Table 5).

Table 5. Proportion of participants in each PGSI category.

	Non-problem gamblers (score 0)	**Low-risk gamblers (score 1-2)**	**Moderate-risk gamblers (score 3-7)**	**Problem gamblers (score >=8)**		**N**
17 years	890 (72.7%)	262 (21.4%)	63 (5.2%)	9 (0.7%)		1224
20 years	1866 (71.1%)	588 (22.4%)	145 (5.5%)	25 (1.0%)		2624
24 years	1503 (78.2%)	305 (15.9%)	84 (4.4%)	29 (1.5%)		1921

Problem gambling was strongly associated with regular gambling at all ages. At age 17 years, 2.8% of those that gambled regularly scored >=8, compared to 0.1% of those that gambled occasionally. The respective numbers for age 20 years was 4.0% compared to 0.3% and at age 24 years, 7.5% compared to 0.4%.

Associations of at-risk/problem gambling

At-risk/problem gambling were much more likely in male gamblers at all ages (Supplementary Tables 6,7,8). Low risk and moderate risk/problem gamblers showed higher scores on hyperactivity (all ages), anti-social behaviour (age 20 and 24 years) and sensation seeking (age 20 and 24 years), and had external locus of control (age 20 and 24 years) (Supplementary Tables 6,7). Lower maternal education level and maternal gambling were also risk factors for at-risk/problem gambling at age 20 and 24 years. Higher depression scores at age 20 years were associated with moderate risk/problem gambling at 24. (Table 6).

Problematic use of alcohol, regular smoking and intake of illicit drugs were all strongly associated with any at-risk (low/moderate/problem) gambling (Table 6). Involvement in crime was higher in at-risk gamblers at age 24 years and at-risk gamblers were also less likely to live away from parents (Table 6). Moderate risk/problem gambling at 24 was strongly associated with higher anxiety scores at 24 years. Adjusted odds ratios for mental health and substance use were highest in the moderate/problem gambling group (Table 6).

Table 6. Summary table of fully adjusted multinomial odds ratios associations of at-risk/problem gambling at each of the three time points and outcomes at age 24.

Only those significant after full adjustment are shown. The sections with diagonal lines are non-significant. Description of variables are provided in Supplementary Table 1.

	Age 17 years		Age 20 years		Age 24 years	
	Low risk	Moderate risk /problem	Low risk	Moderate risk /problem	Low risk	Moderate risk /problem
Mental health						
Depression at 24 years			**1.72 (1.21, 2.45)**	**2.29 (1.28, 4.12)**		
Anxiety at 24 years						**2.06 (1.12, 3.80)**
Drugs & alcohol						
Hard drugs at 24 years	**1.49 (1.07, 2.06)**	**1.95 (1.06, 3.61)**	**1.34 (1.05, 1.70)**	**1.79 (1.16, 2.75)**	**1.39 (1.03, 1.88)**	
Smoking weekly at 24 years			**1.31 (1.01, 1.70)**	**1.84 (1.24, 2.73)**		**1.85 (1.20, 2.85)**
Alcohol disorder at 24 years						
- mild	**1.66 (1.10, 2.50)**	**2.44 (1.27, 4.66)**		**2.11 (1.32, 3.36)**	**1.58 (1.09, 2.28)**	**1.90 (1.07, 3.38)**
- moderate/severe	1.76 (0.85, 3.66)	2.64 (0.81, 8.60)		**3.70 (1.98, 6.91)**	**1.86 (1.04, 3.32)**	**2.64 (1.13, 6.17)**
Social						
Crime at 24 years					**1.75 (1.27, 2.43)**	**2.47 (1.54, 3.97)**
Independent living at 24 years						
- With partner/friends					**0.65 (0.49, 0.86)**	**0.59 (0.38, 0.92)**
- On own					0.57 (0.29, 1.13)	0.77 (0.32, 1.83)

The longitudinal associations between ‘at risk’ and problem gambling between 17 and 24 years are illustrated in figure 4, which contains the odds ratios for the flow between different categories of gambling risk at different ages.
Figure 4 demonstrates that, (for the minority of 6-7% of participants), patterns of moderate risk and problem gambling are established by 20 years old and that there is a very strong correlation (Odds Ratio 43) between problem gambling at 20 and 24 years old.

The characteristics of ‘safe gamblers’ were explored by comparing those that gambled regularly at age 17 but had no problems at age 24 with those that gambled regularly at 17 and did show moderate risk/ problem gambling at 24. These ‘safe’ regular gamblers were more likely to be females, with higher IQs, with more internal locus of control and less likely to have conduct problems at 16 years. They did not drink excessively or use drugs, and were less likely to have mothers that gamble regularly and have problems gambling

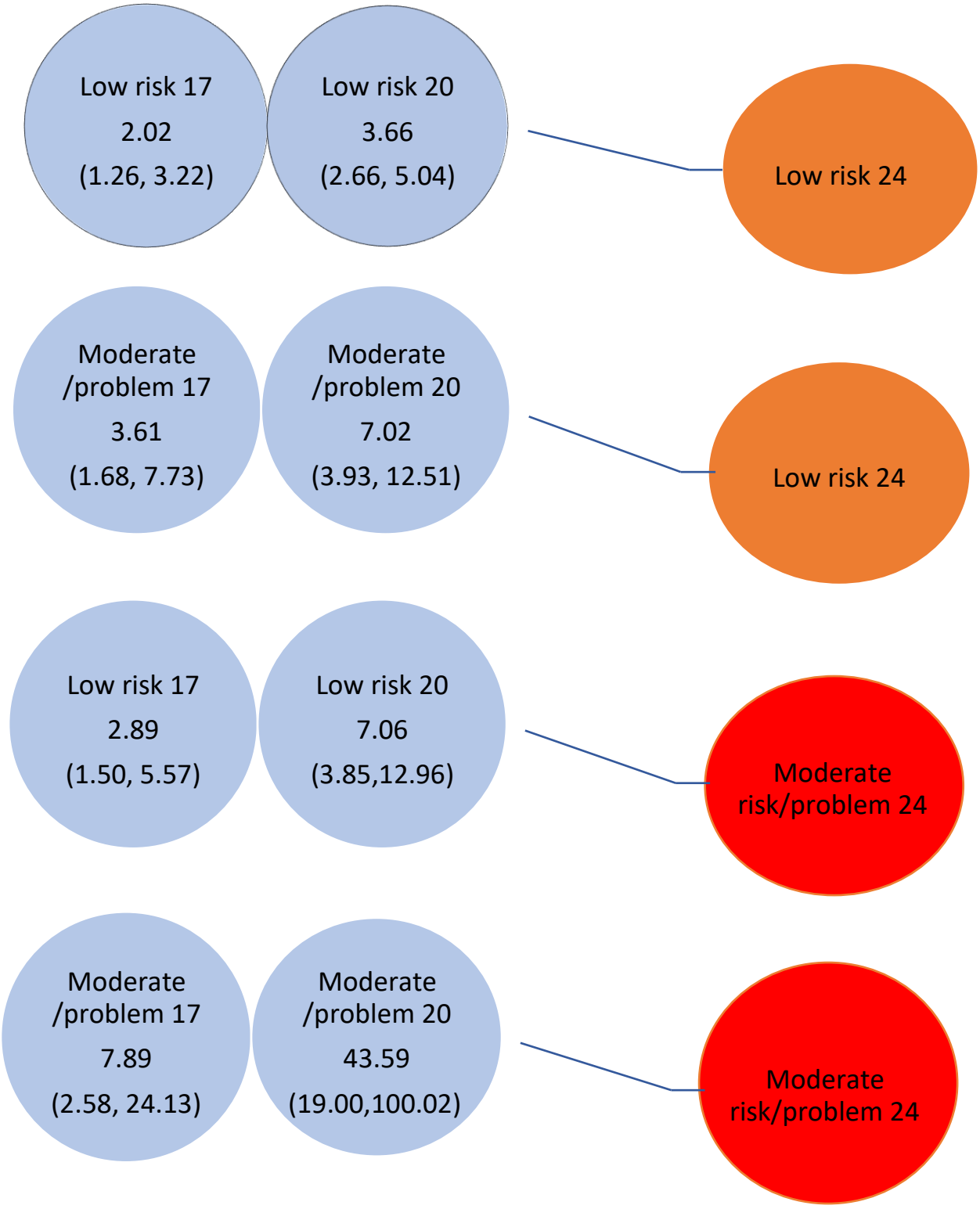

Figure 4. Odds ratios (95%CI) of associations between at risk and problem gambling between 17 and 24 years

DISCUSSION

Summary of key findings

The ALSPAC Gambling Study, utilising an existing cohort of otherwise healthy young people, demonstrated that overall rates of gambling increased between 17 and 24 years, especially in males. Internet betting and gambling showed the largest increase, which likely reflects the widening use of the internet during the study period (2009-2017). Also, 'digital natives' (i.e., those individuals who have never known a world without the internet and smartphones) now engage in many different types of leisure activities online rather than offline, including gambling, gaming, and social networking (Griffiths, 2014, 2015), and these activities have shown increasing convergence (Griffiths, King & Delfabbro, 2014).

Participation in gambling in the past year was reported by 54% of 17-year-olds, rising to 68% at 20 years, and 66% at 24 years, with little overall variance apart from online betting. Between 9% and 12% of young people were regular weekly gamblers, and these patterns were established by age 20 years. Regular gamblers were more likely to be males, from families in which parents gambled, and living in more deprived circumstances (residing in social housing aged 18 years). Individual factors consistently associated with regular gambling were low IQ, high hyperactivity scores, having an external locus of control, and high sensation seeking scores in males. Strong associations were also found with smoking cigarettes, alcohol consumption, and high social media usage. Parental factors associated with regular gambling in young people were past and current gambling, and low maternal educational attainment.

A significant minority (6%-7%) of this population sample of young people were classified as 'moderate risk/problem gambling'. These 'at-risk' gamblers tended to be male regular gamblers, and many of the risk factors were the same as for regular gambling (e.g., the associations with sensation seeking and with higher hyperactivity scores and conduct problems on the SDQ at 16 years). Between 17 and 24 years, any 'at-risk' gambling was associated with higher depression and anxiety scores, and with increased odds of involvement in crime, problematic abuse of alcohol and drug use. Problem gamblers were more likely to have parents who gambled, and the observed associations were stronger with maternal, rather than paternal, gambling. This may reflect the amount of exposure to gambling activity earlier in childhood.

Longitudinal analyses

Although it was disappointing that longitudinal trajectory modelling was not possible due to the lack of variance in gambling behaviour between 17 and 24 years, this is an important finding which confirms that gambling habits in young adulthood appear to be established in adolescence. The predictive odds of being a regular gambler at 24 years clearly demonstrate

the pattern that this behaviour started at 17 years and was established by 20 years. The same pattern was demonstrated for the correlations between at risk and problem gambling between 17- 24 years. Other studies have shown that gambling habits are established by 17 years. For example, the Gambling Commission's report on Young People and Gambling 2018 found that 39% of 11-16 year olds had spent their own money on gambling over the previous year, and a Canadian study reported a median age of gambling onset of 17 years (Auger, 2010). On the other hand, 'safe' gamblers were those that gambled regularly from 17 onwards but did not show any problems at 24 years- these were typically female, who played the lottery or scratchcards every week. They had with higher IQs and more internal locus of control but did not have other addictions and who came from families without a history of parental gambling.

Antecedents of young people's gambling

Individual factors found to be associated with regular gambling from 17-24 years were largely consistent with the literature, with recognised correlations with low IQ (Rai 2013), hyperactivity and impulsivity (Breyer et al., 2009; Faregh & Derevensky 2011), and sensation seeking (Nower et al., 2004). The associations of regular gambling with high external locus of control (feeling low personal control over one's life) were consistent across both sexes. A high external locus of control has been associated with other potentially addictive behaviours, including video gaming (Lloyd, 2019).

There appeared to be a strong association of gaming and gambling with being male. This has been widely reported in literature reviews of both adults and adolescents (e.g., Calado et al., 2017; Calado & Griffiths, 2016) and may be due to multiple reasons from many different perspectives (e.g., evolutionary, biological, psychological, social, etc.). Previous reviews have noted such differences may be due to sex role socialisation, sub-cultural features of gambling, personality differences, motivational gender differences, genetic differences, and differences in psychiatric comorbidity, among others (e.g., Delfabbro, 2000; Holdsworth, Hing & Breen, 2012; Martins, Lobo, Tavares & Gentil, 2002; Merkouris, Thomas et al., 2016).

The rise in use of internet gambling in young males is consistent with (i) the UK Gambling Commission report that 13% of 11-16 year olds had played gambling-style games online and 31% had bought loot boxes within a videogame or app and (ii) findings within the contemporary online gambling literature more generally (e.g., Canale, Griffiths, Vieno et al., 2016; Lopez-Gonzalez & Griffiths, 2018). Regular gamblers in the ALSPAC Gambling Study were boys who had also been players of videogames at 14 years, and the rise in online gambling seen at 20 and 24 years was almost exclusively seen in young men. However, no data were available in the present study about whether the gaming engaged in at 14 years involved loot boxes, so caution must be exercised in ascribing a causal relationship between gaming and subsequent gambling.

As noted above, gambling and betting online showed the largest increase from the ages of 17 to 24 years. Not only is this likely to be a function of the increasing convergence between various online activities (particularly gambling and gaming), but also because the past decade has seen a large increase in sports betting online (Lopez-Gonzalez, Estévez & Griffiths, 2017; Lopez-Gonzalez & Griffiths, 2018), particularly in the form of in-play betting (Killick & Griffiths, 2018; Lopez-Gonzalez, Estévez & Griffiths, 2019) where individuals can now place bets in-game on many markets during the game itself. Online in-play betting is now heavily advertised in the UK and more engaged in by males than females (Lopez-Gonzalez, Estévez & Griffiths, 2018). The rise in popularity of this one specific form of gambling among males may also be a major contributory factor to the increase in betting online among males from the ages of 17 to 24 years.

The most important family factors were parental gambling and educational level. Parental gambling behaviour was strongly associated with their children's regular gambling, with mother's gambling frequency having the strongest effect after adjustment. Vachon et al. (2004) showed that adolescent gambling frequency was related to both parents' gambling frequency and problems, but that adolescent gambling problems were only associated with fathers' severity of gambling problems. Mothers' educational level remained a significant factor for regular gambling in both their male and female children, whereas the effect of SES attenuated after adjustment (see Barnes et al., 1999). A recent systematic review of risk and protective factors for problem gambling suggested protective factors included parental supervision of young people and socio-economic status (Dowling et al., 2017).

Associations and consequences of young people's gambling

After adjustment, at-risk and problem gambling remained associated with depression and anxiety at 20 and 24 years. Although the direction of the association could not be deduced from the dataset, the association was weak with depression and at-risk gambling at 17 years, and much stronger at 20 years. Although the international literature suggests that depression has a consistent association with problem gambling at all ages, and is seen particularly with older female gamblers, the present study did not observe a female preponderance. Quigley et al. (2015) reported that problem gamblers with comorbid depression have more severe gambling problems, greater history of childhood abuse and neglect, poorer family functioning, higher levels of neuroticism, and lower levels of extraversion. The pathways approach to youth gambling (Nower and Blaszczynski. 2005) distinguishes between behaviourally conditioned problem gamblers, those who gamble as a means of emotional escape and mood regulation, and those young people with a biological vulnerability toward impulsivity and arousal-seeking,

with attentional deficits and antisocial traits. Evidence of the last two of these pathways of youth gambling was apparent in the ALSPAC dataset.

Alcohol and drug abuse were clear co-morbidities of regular and at-risk gambling at all ages, with the strongest correlations with moderate risk/problem gambling at 20 and 24 years. These correlates have been shown in many other studies of youth gambling. For example, a study of youth gambling in Norway (Molde et al., 2009) also showed that male gender, depression, alcohol abuse, and dissociation were related to problem gambling. Gupta et al. (2004) reported that youths who gamble excessively exhibited coping styles that were more emotion-based, avoidant, and distraction-oriented, and were more likely to engage in other addictive behaviours. Petry and Weinstock (2007) demonstrated associations in college students between internet gambling and poor mental health. Potenza et al. (2011) showed that at-risk/problem internet gambling was associated with heavy alcohol use, low peer involvement, and poor academic functioning**.** The clear conclusion is that the concept of 'harm' associated with youth gambling should not just include financial consequences, but also poor mental health and other potentially addictive behaviours.

Strengths and limitations of ALSPAC Gambling Study

The strength of the present study is in its use of the large ALSPAC cohort, which has collected a wealth of data for over 25 years. When this cohort was initiated in 1991, it was representative of a whole community and it covered a range of environments from inner city to semi-rural in one geographical area. The ALSPAC study has also collected a diverse range of psychological and physical measures from both the children and their families. Gambling activity at 17, 20, and 24 years was self-reported by the young people, not by their parents, and a wealth of background information was available on these families. Mental health data include self-report measures of both anxiety and depression.

The main limitation of the research is the missing data, with less than half of the whole cohort completing the gambling station in the 17+ years research clinic or completing the online surveys. Non-responders to the gambling surveys, when compared to responders, were more likely to be male and from more deprived social backgrounds, with mothers with lower educational levels. Multiple imputation techniques were used to minimise the bias from attrition, but the analyses probably underestimated the prevalence of regular gambling. There was also a significant gender bias, with the final sample comprising 58% females. As males were more likely to engage in all types of gambling activity, this gender bias in reporting will have resulted in an under-estimate of gambling prevalence and associated characteristics. Additionally, it should be noted that the ALSPAC sample was predominately white, with few young people from Black or Asian heritage to permit any valid comparisons of gambling

behaviour in different ethnic groups. All the gambling data were self-report in nature, and therefore were subject to many biases including social desirability and memory recall.

Although data from cohorts at three time-points were collected, the data did not allow full utilization of the longitudinal nature of the study, and so causal inferences should be interpreted with caution.

No data were available on the type of gambling products used by the participant, nor on the money spent on gambling

CONCLUSIONS

In conclusion, although many young people gamble without any harm, a significant minority (mainly males) show problem gambling behaviours which are associated with poor mental health, involvement in crime, and potentially harmful use of drugs and alcohol. Many young people had tried different forms of gambling between 17 and 24 years, but the only activity showing a consistent increase over this age range was online gambling and betting. Patterns of problem/moderate risk gambling were set by the age of 20 years.

The concept of 'harm' for young gamblers needs to include the impacts of gambling on mental health and the associated harmful use of drugs and alcohol, and the effects on social relationships.

SUGGESTIONS FOR FUTURE RESEARCH

Based on the findings presented here, the following recommendations are suggested:

- A further sweep of the ALSPAC cohort, using the same gambling measures, is needed at 30 years to investigate whether the trends observed between 17 and 24 years are maintained into adulthood.
- The relationship between gaming and gambling in youth needs further exploration, to determine to what degree online gaming is an entry into problem gambling, particularly for vulnerable males.
- The 'push' and 'pull' factors behind young adult males gambling online needs further evidence to provide guidance for the gambling industry and inform policymakers and legislation if necessary.
- More investigation is required of protective factors for young people to gamble safely, and to adequately guide prevention initiatives.

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GambleAware is a wholly independent charity, which delivers the research components of the National Strategy to Reduce Gambling Harms within the context of arrangements based on voluntary donations from the gambling industry. Research priorities are set and commissioned in isolation from the gambling industry and no-one with a background in the gambling industry can be a member of GambleAware's Research Committee or Board of Trustees. The charity's research commissioning and governance procedure can be found on the website: www.about.gambleaware.org

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APPENDIX

Contents:

Supplementary Material 1: **Variables used in analyses**.

Unless otherwise stated, data stem from questionnaires.

Variable	Age (years)	Description
Child antecedents		
IQ	8	A short version of the WISC III[1] applied by trained psychologists in research clinic was used. We used the total IQ (verbal + performance) and compared the % of people in the bottom quartile to the rest (score <90).
Computer games	13	Teenagers were asked whether they chose to play computer games with other children instead of other activities. This was used as a binary yes/no variable.
Hyperactivity and conduct problems	16.5	Measured using the Strengths and Difficulties Questionnaire (SDQ). Scores were entered as binary variables based on cut-offs for 'abnormal' scoring on each SDQ subscale as suggested by Goodman.[2]
Locus of control	16.5	Calculated summing the answers on a 12 item Nowicki-Strickland Locus of Control Scale[3]. People with a lower score believe that an outcome is largely contingent upon their own behaviour and are having a more *internal* locus of control, whereas those with a higher score believe that luck, fate, chance or powerful others largely determine an outcome are more *external*. Scores greater than the median were labelled external and less than or equal to the median were labelled internal.

Sensation seeking	17	A total sensation seeking score (novelty subscale + intensity subscale) was measured using the Arnett Sensation Seeking Scale[4]. A higher score indicates a higher tendency to pursue sensory pleasure and excitement.
Stressful life events	16	Teenagers were asked in a series of questions whether they had experienced major stressful events such as death of a family member, pregnancy, arrival of siblings etc. since the age of 12. A summed continuous score was used for analyses.
Education/employment status	17, 20	Participants were asked whether they were in education or employment (full or part-time). This was used as a binary yes/no variable.
Depression	17	An ICD-10 diagnosis of depression (yes/no) established in a research clinic was used.
Smoking	16.5, 20, 23	Participants were asked about cigarette smoking habits. We used the % of weekly smokers compared to those that did not smoke weekly.
Alcohol consumption	16, 20, 23	Alcohol consumption was measured slightly differently at each time point. At age 16, we used the % of weekly alcohol intake compared to the rest. At age 20, we used the % of harmful alcohol use compared to the rest and at age 23, we used the DSM4 criteria of alcohol abuse (yes/no).
Social media use	24	Measured as the frequency of using social media. We compared the % using it >10 times/day to those that used it less frequently.
Maternal/socioeconomic antecedents		
Maternal age	At birth	We used the % of women above or below the mean age of all women at the birth of their child.

Maternal education	32 weeks gest.	Measured as the highest education level the mother held. It was classified as CSE (Certificate of Secondary Education)/none, Vocational, O level, A level, Degree. We compared the proportion of mothers with a degree compared to those with levels below a degree.
Maternal and partner depression	Child aged 12	Mother and mother's partner were asked if they had experienced depression (yes/no) in the past 2 years.
Maternal/paternal gambling	Child aged 6, 18	Questionnaire data on maternal and paternal gambling were collected using the South Oaks Gambling Screen[5] when the children were aged 6 years. We compared weekly parental gambling to the rest. Maternal gambling data was also collected using the Canadian Problem Gambling Index[6] where mothers were classified into nongamblers, no-problem gamblers, low risk gamblers, moderate risk gamblers and problem gamblers.
Crowding index	8 weeks gest.	Calculated by dividing the number of people in the household by the number of rooms and categorizing as [0, 0.5], [0.5, 0.75], [0.75, 1], [> 1]. The higher the number, the more crowded a household. We compared the proportion with an index of >1 to the rest.
Financial difficulties	32 weeks gest.	A numerical score was created from five questions about how difficult the mothers found affording certain items. The higher the score the more financial difficulties. We compared the top tertile with the rest.

Index of multiple deprivation	Child aged 11	IMD is created from census data on 7 socioeconomic domains: income; employment; health and disability; education, skills and training; barriers to housing and services; living environment; and crime. The IMD was based on the address of the family when the child was 11 years old; the highest IMD quintile indicates the greatest social deprivation.
Housing	Child aged 18	Mothers were asked about their housing situation. We used a derived variable comparing

		those living in council/housing association to those who owned their own or private renting
Correlates of problem gambling		
Depression	24	The Computerised Interview Schedule – Revised (CIS-R) is a self-administered computerized interview which derives diagnoses based on ICD-10 criteria for depression and anxiety disorder (yes/no).[7]
Anxiety	24	The Computerised Interview Schedule – Revised (CIS-R) is a self-administered computerized interview which derives diagnoses based on ICD-10 criteria for depression and anxiety disorder (yes/no[7]
Self-harm	24	Ever attempted self-harm (yes/no). Part of the CIS-R (see above).

Crime	24	Whether participant has ever engaged in violent (includes snatching with force, fighting and carrying a weapon) or non-violent crime (includes shoplifting, vandalism, breaking in vehicle, joyriding, selling drugs, breaking into house, selling stolen goods, arson, snatching without force, buying stolen goods, fraud, and claiming untitled benefits) in the past 12 months (yes/no).[8]
Illicit drugs	24	Whether participant has used drugs such as cocaine, crack, ecstasy etc. in the past 12 months (yes/no).
Cannabis	24	Frequency participant has used cannabis in the past 12 months. We compared weekly or more to the rest.
Smoking cigarettes	24	Frequency of smoking cigarettes. We compared weekly or more to the rest.
Alcohol consumption	24	'alcohol use disorder scores' as defined by the Diagnostic and Statistical Manual of Mental Disorders V (DSM-V). We compared those that scored for moderate/severe disorder to those that scored for mild and none.
Employment status	24	Whether participant is in part-time or full employment.
Independent living	24	Measures current living arrangements (living on own, living with partner/friend or living with parents).

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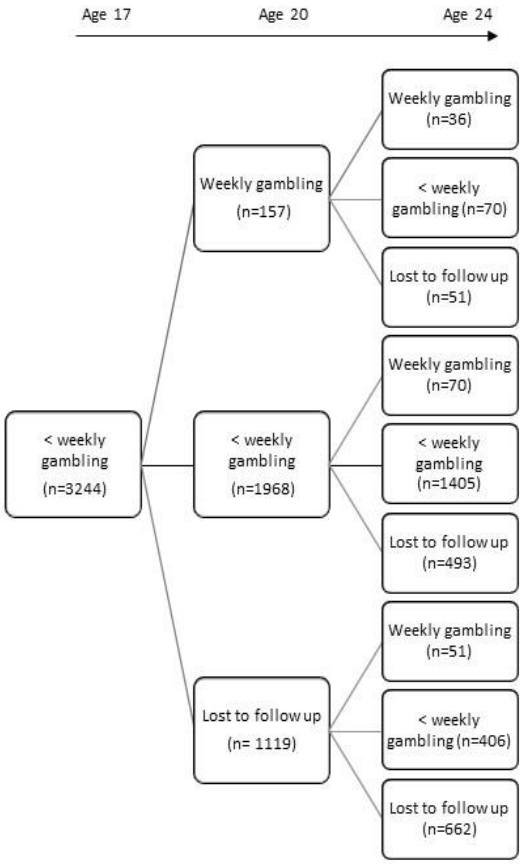
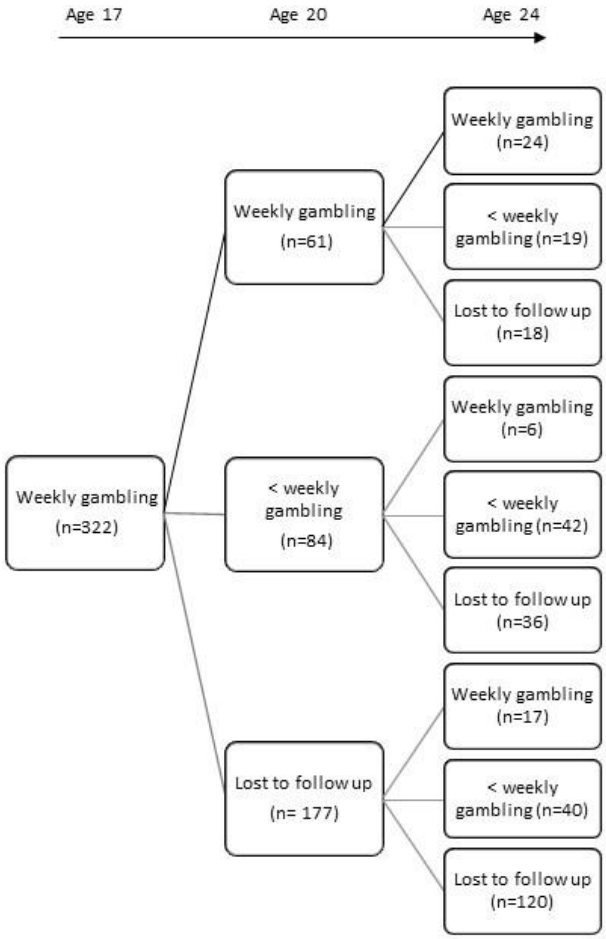
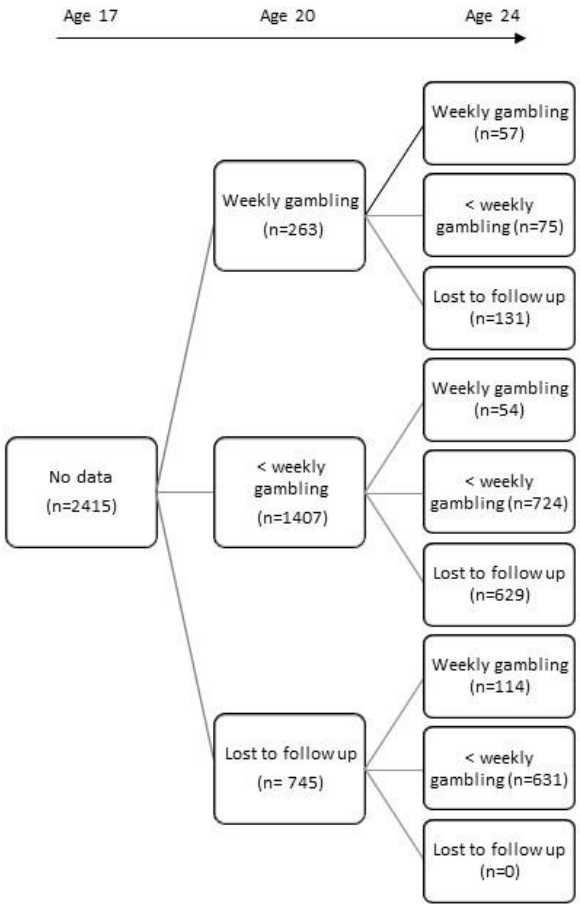


Supplementary Figure 2a. Flow chart illustrating numbers of responses available for occasional gamblers (<weekly) at age 17 years



Supplementary Figure 2b. Flow chart illustrating numbers of responses available for regular (> weekly) gamblers at age 17 years



Supplementary Figure 2c. Flow chart illustrating numbers of responses available for participants with no data at 17, but with gambling data at age 20 and 24 years

Supplementary Table 3. Univariable results on the association between child antecedents and gambling activity at age 17 years.

Age 17				
Variables*	**No gambling (N tot=1632)**	**Occasional gambling (< Weekly) (N tot=1612)**	**Regular gambling (≥ Weekly) (N tot=322)**	***p*-value****
Gender (% male)	36.0%	44.4%	62.7%	**<0.001**
IQ at 8 (% bottom quartile [<90])	14.5% n=1383	14.7% n=1349	29.6% n=253	**<0.001**
Plays computer games with other children at 13/14 (% yes)	55.8% n=1372	62.2% n=1322	68.8% n=253	**<0.001**
Hyperactivity at 16.5 (% abnormal; score 7-10)	3.6% n=1308	3.8% n=1228	9.2% n=207	**0.001**
Conduct problems at 16.5 (% abnormal; score 4-10)	4.4% n=1306	3.2% n=1226	9.7% n=207	**<0.001**
Locus of control at 16.5 (% >median [external])	32.6% n=1211	32.9% n=1179	53.4% n=178	**<0.001**
Sensation seeking at 17 (mean (SD))	51.4 (7.3) n=976	52.7 (7.1) n=890	53.3 (7.2) n=128	**<0.001**
Stressful life events age 16 (mean (SD))	2.8 (2.0) n=1287	2.9 (2.0) n=1243	3.0 (2.4) n=241	0.24
In education or employment age 17 (% no)	9.3% n=1424	10.6% n=1384	20.9% n=277	**<0.001**
Depression at 17 (ICD-10 diagnosis = % yes)	7.5% n=1481	7.0% n=1459	9.5% n=284	0.33

Smoking cigarettes at 16.5 (% ≥ weekly)	7.1% n=1288	10.7% n=1243	20.5% n=195	**<0.001**
Alcohol use at 16.5 (% weekly)	12.6% n=1187	15.6% n=1189	19.6% n=184	**0.002**

Supplementary Table 4. Univariable results on the association between child antecedents and gambling activity at age 20 years.

	Age 20 years			
Variables*	**No gambling (N tot=1259)**	**Occasional gambling (< Weekly) (N tot=2200)**	**Regular gambling (≥ Weekly) (N tot=481)**	***p*-value****
Gender (% male)	31.9%	39.5%	59.5%	**<0.001**
IQ at 8 (% bottom quartile [<90])	13.3% n=999	16.6% n=1740	22.5% n=356	**<0.001**
Plays computer games with other children at 13/14 (% yes)	53.2% n=965	59.6% n=1624	71.1% n=329	**<0.001**
Hyperactivity at 16.5 (% abnormal; score 7-10)	3.4% n=994	4.2% n=1624	5.9% n=337	0.13
Conduct problems at 16.5 (% abnormal; score 4-10)	4.0% n=992	3.8% n=1624	4.2% n=336	0.94
Locus of control at 16.5 (% >median [external])	33.9% n=975	36.3% n=1553	44.2% n=317	**0.004**
Sensation seeking at 17 (mean (SD))	51.1 (7.3) n=808	52.4 (7.3) n=1219	52.9 (7.0) n=231	**<0.001**
Stressful life events age 16 (mean (SD))	2.9 (2.0) n=1036	3.0 (2.1) n=1655	2.7 (2.0) n=331	0.19
In employment or education/training at 21 (% no)	8.7% n=1209	7.0% n=2115	11.9% n=454	**0.002**
Depression at 17 (ICD-10 diagnosis = % yes)	8.8% n=865	6.4% n=1419	8.1% n=272	0.10
Smoking cigarettes at 21 (% weekly)	13.4% n=1228	21.1% n=2158	26.2% n=465	**<0.001**

Alcohol use at 21 (% harmful use)	8.1% n=1119	13.6% n=2057	18.0% n=445	**<0.001**

** *p*-values stem from Chi-square tests or ANOVAs.

Supplementary table 5. Univariable results on the association between child antecedents and gambling activity at age 24 years.

	Age 24 years			
Variables*	**No gambling (N tot=1292)**	**Occasional gambling (< Weekly) (N tot=2120)**	**Regular gambling (≥ Weekly) (N tot=429)**	***p*-value****
Gender (% male)	30.0%	34.9%	54.6%	**<0.001**
IQ at 8 (% bottom quartile [<90])	16.8% n=1022	16.6% n=1643	21.1% n=323	0.15
Plays computer games with other children at 13/14 (% yes)	52.7% n=972	57.2% n=1519	66.2% n=305	**<0.001**
Hyperactivity at 16.5 (% abnormal; score 7-10)	3.2% n=970	3.8% n=1546	5.2% n=269	0.30
Conduct problems at 16.5 (% abnormal; score 4-10)	4.2% n=971	3.9% n=1548	4.5% n=268	0.89
Locus of control at 16.5 (% >median [external])	34.0% n=950	36.8% n=1436	39.5% n=253	0.18
Sensation seeking at 17 (mean (SD))	51.2 (7.5) n=791	52.0 (7.3) n=1147	51.8 (7.6) n=187	0.09
Stressful life events age 16 (mean (SD))	2.9 (2.0) n=1009	3.0 (2.1) n=1532	2.7 (1.9) n=267	0.23
In employment or education/training at 21 (% no)	6.6% n=945	6.2% n=1411	10.5% n=257	**0.04**
Diagnosed depression at 23 (% yes)	21.5% n=993	18.9% n=1474	19.3% n=275	0.28
Smoking cigarettes at 23 (% weekly)	10.0% n=998	14.7% n=1490	22.6% n=275	**<0.001**

Alcohol abuse at 23 (% yes)	6.7% n=987	9.6% n=1475	11.6% n=267	**0.01**
Social media use at 24 (% >10 times a day)	33.7% n=1256	40.4% n=2078	43.7% n=414	**<0.001**

* Variables are explained in supplementary Table 1. ** *p*-values stem from Chi-square tests or ANOVAs.

Supplementary Table 6. Univariable results on the association between child and parental antecedents and problem gambling at age 17 years.

Variables	Non-problem (Ntot = 890)	Low risk (Ntot=262)	Moderate risk/problem (Ntot = 72)	*p*-value
Gender (% male)	46.3%	63.0%	65.3%	**<0.001**
IQ at 8 (% bottom quartile [<90])	11.6% n=749	17.1% n=211	17.9% n=56	0.07
Hyperactivity at 16.5 (% abnormal; score 7-10)	3.1% n=675	3.8% n=184	18.0% n=50	**<0.001**
Conduct problems at 16.5 (% abnormal; score 4-10)	3.1% n=675	4.9% n=183	8.2% n=49	0.13
Locus of control at 16.5 (% >median [external])	32.4% n=667	34.5% n=168	42.1% n=38	0.43
Sensation seeking at 17 (mean (SD))	53.3 (7.0) n=512	53.7 (6.4) n=138	55.9 (7.1) n=24	0.18
Regular gambling at 17 (% weekly)	14.4% n=807	27.4% n=237	53.9% n=65	**<0.001**
Maternal education pregnancy (% with degree higher than A level)	17.9% n=837	17.4% n=230	25.0% n=64	0.65
Financial difficulties pregnancy (% difficulty score >3)	22.5% n=814	22.3% n=224	25.4% n=63	0.98
Maternal gambling child age 6 (% ≥ Weekly)	39.8% n=739	46.1% n=206	50.0% n=52	0.18
Paternal gambling child age 6 (% ≥ Weekly)	53.5% n=467	54.3% n=129	60.7% n=28	0.63
Maternal problem gambling* **(% at risk/problem)**	2.5% n=557	0.7% n=135	5.1% n=39	0.14

* Study child aged 17-20 years

Supplementary Table 7. Univariable results on the association between child and parental antecedents and problem gambling at age 20.

Variables	Non-problem (Ntot = 1866)	Low risk (Ntot=588)	Moderate risk/problem (Ntot = 170)	*p*-value
Gender (% male)	38.3%	51.9%	74.1%	**<0.001**
IQ at 8 (% bottom quartile [<90])	15.9% n=1463	20.2% n=445	18.5% n=135	0.10
Hyperactivity at 16.5 (% abnormal; score 7-10)	3.3% n=1405	5.0% n=397	10.3% n=116	**0.001**
Conduct problems at 16.5 (% abnormal; score 4-10)	3.4% n=1404	4.0% n=396	9.5% n=116	**0.004**
Locus of control at 16.5 (% >median [external])	33.8% n=1337	42.1% n=399	45.0% n=109	**0.002**
Sensation seeking at 17 (mean (SD))	52.3 (7.2) n=1070	53.6 (7.4) n=302	54.6 (5.9) n=65	**0.002**
Regular gambling at 20 (% weekly)	11.7% n=1631	27.4% n=529	61.8% n=152	**<0.001**
Maternal education pregnancy (% with degree higher than A level)	18.3% n=1750	13.8% n=530	12.6% n=159	**0.03**
Financial difficulties pregnancy (% difficulty score >3)	25.2% n=1713	26.2% n=519	33.3% n=156	0.24
Maternal gambling child age 6 (% ≥ Weekly)	42.0% n=1558	41.8% n=469	43.2% n=139	0.47
Paternal gambling child age 6 (% ≥ Weekly)	52.0% n=957	56.6% n=258	54.1% n=74	0.31
Maternal problem gambling* (% at risk/problem)	2.3% n=1109	2.0% n=299	7.7% n=91	**0.03**

* Study child aged 17-20 years

Supplementary Table 8. Univariable results on the association between child and parental antecedents and problem gambling at age 24 years.

Variables	Non-problem (Ntot = 1503)	Low risk (Ntot=305)	Moderate risk/problem (Ntot = 113)	*p*-value
Gender (% male)	39.0%	52.8%	67.3%	**<0.001**
IQ at 8 (% bottom quartile [<90])	11.6% n=1200	22.3% n=238	20.5% n=88	**<0.001**
Hyperactivity at 16.5 (% abnormal; score 7-10)	2.5% n=1135	5.0% n=199	10.3% n=78	**<0.001**
Conduct problems at 16.5 (% abnormal; score 4-10)	3.3% n=1136	5.0% n=199	15.6% n=77	**<0.001**
Locus of control at 16.5 (% >median [external])	31.2% n=1065	43.3% n=187	38.7% n=62	**0.004**
Sensation seeking at 17 (mean (SD))	52.6 (7.4) n=878	52.3 (7.0) n=138	55.9 (5.5) n=38	**0.02**
Regular gambling at 24 (% weekly)	12.1% n=1177	30.7% n=283	61.7% n=107	**<0.001**
Maternal education pregnancy (% with degree)	22.1% n-1457	14.6% n=287	12.7% n=110	**0.005**
Financial difficulties pregnancy (% difficulty score >3)	23.3% n=1419	27.2% n=279	28.0% n=107	0.09
Maternal gambling child age 6 (% ≥ Weekly)	39.7% n=1281	40.9% n=259	49.5% n=97	**0.03**
Paternal gambling child age 6 (% ≥ Weekly)	49.6% n=818	52.1% n=144	53.9% n=52	0.82
Maternal problem gambling* (% at risk/problem)	1.7% n=921	5.0% n=160	6.6% n=61	**0.004**

* Study child aged 17-20 years