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Psychosocial factors behind addiction—a six-wave longitudinal comparison of at-risk gambling and drinking

Sari Hautamäki[1,*], Iina Savolainen[1], Emmi Kauppila[1], Anu Sirola[2], Atte Oksanen[1]

[1]Faculty of Social Sciences, Tampere University, Kalevantie 4, Tampere 33014, Finland
[2]The Department of Social Sciences and Philosophy, University of Jyväskylä, PL 35, Jyväskylä 40014, Finland

*Corresponding author. Faculty of Social Sciences, Tampere University, Kalevantie 4, 33014 Tampere, Finland. E-mail: sari.hautamaki@tuni.fi

Abstract

Aims: Research indicates that shared and specific underlying factors influence different addictions, sometimes resulting in co-occurring problems. The evidence concerning risk and protective factors for gambling and alcohol addiction, along with their co-occurrence, remains ambiguous. To address this gap, this study will conduct longitudinal research to examine the factors associated with at-risk behaviours over time.

Methods: We utilize a sample of 18- to 75-year-old participants ($N = 1530$) from Finland. Participants were surveyed every six months between 2021 and 2023, covering six rounds of data collection (in total 6650 observations). Measures included the Alcohol Use Disorders Identification Test and the Problem Gambling Severity Index. The analysis used multilevel regression models to investigate risk and protective factors over time.

Results: Based on population-average models, younger age and being a man were associated with all examined dependent variables. Psychological distress, a sense of belonging to family and friends, and belonging to an online community were associated with at-risk gambling. At-risk drinking was associated with education and income, marital status, and the sense of belonging to family and friends. Being in debt enforcement, education, and psychological distress were associated with the co-occurrence of the two addictive behaviours. The fixed effects highlighted the importance of psychological distress in the development of co-occurring gambling and drinking problems.

Conclusion: The findings indicate that partly different sociodemographic and psychosocial factors are important underlying contributors to alcohol and gambling problems. Psychological distress is a particularly crucial factor predicting co-occurring at-risk gambling and drinking, indicating that co-occurrence is accompanied by psychological burden.

Keywords: at-risk drinking; at-risk gambling; co-occurring addiction; longitudinal design

Introduction

Addictions are significant public health concerns that result in numerous detrimental effects and expenses for both individuals and societies. They have lasting impacts on individuals' physical and mental health, as well as their social and financial well-being (Rehm *et al*. 2017; Abbott 2020). Addictions can be substance-related (e.g. alcohol, drugs) or behavioural (e.g. gambling, internet, sex). Previous research suggests that engaging in at-risk behaviours increases the likelihood of developing more severe forms of addiction (El-Guebaly *et al*. 2015; Dowling *et al*. 2017). Although this process is well known from addiction research, there is a need for longitudinal research on the topic. The identification of individual risk factors for various addictions, especially the co-occurrence between different addictive behaviours, has not been adequately studied using a longitudinal research design. Existing research on addiction comorbidities and co-occurrences (Suomi *et al*. 2014; Ford and Håkansson 2020; Estévez *et al*. 2021) has predominantly relied on cross-sectional methodologies. Even though longitudinal evidence exists as well, most of the existing longitudinal evidence has focused more on either gambling or drinking or the role of a third factor (Afifi *et al*. 2016; Dowling *et al*. 2017; Allami *et al*. 2018) and do not simultaneously address multiple psychological and social background factors. This study aims to fill this gap by comparing the risk factors of at-risk gambling and drinking and their co-occurrence, which are two prevalent public health concerns (Ford and Håkansson 2020).

Research from the past decades has provided substantial evidence supporting the comorbidity or co-occurrence of problematic gambling, drinking, and substance use (Dowling *et al*. 2017; Allami *et al*. 2018). Comorbidity has also been addressed in theory, suggesting that it stems from shared underlying factors behind addictions. The Syndrome Model of Addiction (Shaffer *et al*. 2004) approaches addictions as one syndrome in which various addictive behaviours, such as gambling and drinking, are viewed as manifestations of an underlying syndrome. According to this model, addictions emerge from shared neurobiological and psychological antecedents and shared life experiences. This theoretical base indicates that the risk factors and determinants of at-risk drinking and gambling are similar.

While not always co-occurring, evidence suggests that problematic drinking and gambling share similar risk factors. It has been shown that men, young people, and single individuals are more likely to engage in problem gambling and drinking (Suomi *et al*. 2014; Grigsby *et al*. 2016; Nordmyr *et al*. 2016; Dowling *et al*. 2017; Allami *et al*. 2021). Furthermore, lower

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income, unemployment, and financial struggles are connected to a higher risk of drinking and gambling addictions (Dowling *et al*. 2017; Muggleton *et al*. 2021; Moreira *et al*. 2023; Dagne *et al*. 2024). Unemployment may free up time for gambling and drinking, whereas financial difficulties or low income can motivate gambling frequency, and people who gamble with financial motives may be more prone to problematic gambling (Tabri *et al*. 2022).

Research evidence considering education has been incoherent. A recent systematic review suggests that high-risk gamblers are usually more educated (Moreira *et al*. 2023), but a meta-analysis connects lower education to problematic gambling (Allami *et al*. 2021). Similar factors pertaining to socioeconomic status, such as education, have been associated with at-risk drinking, but the results have been somewhat ambiguous (Grigsby *et al*. 2016; Dagne *et al*. 2024).

Research has consistently shown that there is a positive association between mental health issues, perceived stress, and problem drinking (Grigsby *et al*. 2016; Micu *et al*. 2019; Dagne *et al*. 2024) and gambling (Allami *et al*. 2021; Moreira *et al*. 2023). Moreover, having sufficient social connections, networks, and attachment to family are seen as protective factors against problematic drinking (Micu *et al*. 2019). Social ties and relationships with others have been associated with both problem gambling and problem drinking (Stogner *et al*. 2015; Nordmyr *et al*. 2016; Micu *et al*. 2019; Allami *et al*. 2021). Social connections and antisocial behaviours are associated with problematic gambling (Dowling *et al*. 2017; Vuorinen *et al*. 2021), and having social connections with other gamblers in online communities is associated with positive gambling attitudes and the emergence of addiction (Savolainen *et al*. 2022). Loneliness has also been associated with problematic drinking and gambling, but the associations seem to differ between risky behaviours and demographics (Suomi *et al*. 2014; Edgren *et al*. 2016; Nordmyr *et al*. 2016; Savolainen *et al*. 2018).

Although there are some common factors that explain both risky gambling and drinking behaviours, theory and empirical research also suggest that there are differences in their risk and protective factors. This indicates that each addiction has unique characteristics and underlying processes (Sussman *et al*. 2011). Biopsychosocial approaches to addiction specificity (Sussman *et al*. 2011) and the components model of addiction (Griffiths 2005) highlight the interplay between many factors and individual differences behind different addictions. Empirical evidence shows that behavioural addiction and substance misuse groups differ demographically and psychosocially (Suomi *et al*. 2014), and the inconsistent evidence of alcohol misuse risk factors further indicates addiction specificity, justifying a focus on at-risk drinking instead of focusing on both at-risk drinking and substance use in research. These theories help us understand why each type of addiction may have its own distinct characteristics (Sussman *et al*. 2011). However, empirical evidence is still needed.

The aim of this study is to compare the underlying risk and protective factors associated with at-risk drinking, at-risk gambling, and their co-occurrence to better understand the distinguishing differences and shared features of these behaviours. This study provides a valuable longitudinal perspective on the topic, utilizing population-based data. The research questions that guided our study were:

RQ1: What are the risk and protective factors for at-risk gambling?

RQ2: What are the risk and protective factors for at-risk drinking?

RQ3: What are the risk and protective factors that contribute to the simultaneous occurrence of at-risk gambling and drinking?

Materials and methods

Participants and procedure

We utilized longitudinal survey data gathered in the [ANONYMIZED] project to study addictive behaviours, including gambling, digital gaming, and alcohol use and their effects on the Finnish population. Participants were recruited from a volunteer online panel administered by Norstat Finland. They were invited to take part in the study through email and the provider's mobile application. As compensation, the respondents were offered Norstat coins for their participation. The survey was targeted to adults aged 18–75 in mainland Finland in spring 2021 (T1: $N = 1530$), with subsequent waves every 6 months until wave six in fall 2023. Data were collected as follows: T2 ($n = 1198$, response rate 78.30% of T1 respondents), T3 ($n = 1095$, response rate 71.57% of T1 respondents), T4 ($n = 1004$, response rate 65.62% of T1 respondents), T5 ($n = 934$, response rate 61% of T1 respondents), and T6 ($n = 889$, response rate 58% of T1 respondents). The data include, in total, 6650 observations. Out of all participants, 753 responded to all six time points.

The T1 sample closely matched the Finnish adult population aged 18–75 in terms of gender, geographical area, income, marital or occupational status, and education level. Attrition analysis showed that younger respondents dropped out at a higher rate. Otherwise, there are no major socio-demographic deviances in drop out and all time points match the Finnish population relatively well [citation ANONYMIZED].

The ethics committee of the [ANONYMIZED] region in Finland declared in their 2021 statements that the protocols for this research did not present any ethical issues (Statements [ANONYMIZED]).

Measures

In the analysis, three different dichotomic dependent variables were used. At-risk gambling was measured with the Problem Gambling Severity Index (PGSI; Currie *et al*. 2010), which is widely used and psychometrically valid for assessing problematic gambling (e.g. Raisamo *et al*. 2015; Gorenko and Konnert 2023). The measure consists of nine items designed to assess various aspects and consequences of problematic gambling behaviour. These include financial problems caused by gambling, feelings of guilt or remorse related to gambling, and the impact of gambling on personal relationships. Responses were rated on a scale from 0 to 3 (0 = never, 1 = sometimes, 2 = most of the time, and 3 = almost always). A total score of three points or more was used for determining moderate at-risk gambling as suggested in the literature (Williams *et al*. 2015). None of those who had co-occurring at-risk alcohol use were included in the measure. According to McDonald's omega values, the internal consistency of the PGSI measure ($\omega = 0.93$–0.94) was high at each time point.

At-risk drinking was assessed with the three-item Alcohol Use Disorders Identification Test (AUDIT-C; Bush *et al*. 1998). The items generated risk scores ranging from 0 to 12, where higher scores indicated at-risk or hazardous drinking

behaviours. This measure has been validated in numerous studies across diverse populations, demonstrating its reliability and effectiveness in assessing at-risk drinking habits (Lundin *et al.* 2015; Duffy *et al.* 2023). We utilized cut-off values of five points for women and six points for men in line with other Finnish population studies. In the European context in general population samples, cut-off scores of ≥ 5 and ≥ 6 for AUDIT-C have been validated for the measurement of risky drinking (e.g. Tuunanen *et al.* 2007) and used by official instances (Office of Health and Disparities 2017; The Finnish Institute of Health and Welfare 2023). Participants who displayed indications of at-risk gambling were subsequently excluded from the measure. McDonald's omega values demonstrated high internal consistency across different time points ($\omega = 0.81$–0.84). According to the same cut-off values, the participants who reported both at-risk gambling and drinking were grouped together to measure the co-occurrence of the two.

The independent variables were selected based on previous research and the availability of the data. The sociodemographic variables included age, gender (man/woman), employment status (unemployed, laid off, looking for a job/other), income level (earning 1000 euros or less per month to 7000 euros or more per month), education level (university or university of applied sciences degree/lower), experience with debt enforcement (actively undergoing/already paid off, or never been), and civil status (married/other).

Psychosocial measures included psychological distress assessed using the five-item Mental Health Inventory (MHI-5; Cuijpers *et al.* 2009), which included items considering respondents' emotional and psychological states during the last month. Answers were given on a scale ranging from one (none of the time) to six (all the time). Total scores on the scale ranged from 5 to 30, with higher scores indicating higher levels of distress. The scale demonstrated good internal consistency at each time point ($\omega = 0.87$–0.89).

Sense of belonging with family and friends was measured using the Social and Emotional Loneliness Scale for Adults (SELSA, DiTommaso and Spinner 1993; DiTommaso *et al.* 2004). The SELSA scale includes three different subscales (connections to family, to friends, and to a loved one). The three subscales include nine statements about family, friends, and a loved one (e.g. 'My family is important to me', 'I'm in love with someone, who is in love with me', and 'I can depend upon my friends for help'). Responses for all statements were given on a scale of 1 (strongly disagree) to 7 (strongly agree), leaving a total score ranging from 9 to 63. The scale had high internal consistency ($\omega = 0.85$–0.87) in the sample. Based on SELSA, we included a three-item subscale for belonging to friends online or an internet community that consisted of statements such as 'My internet community is important to me'. The total score on the subscale ranged from 3 to 21 with high internal consistency ($\omega = 0.94$–0.95).

Statistical analysis

The analysis was conducted using Stata 18 software. We present descriptive findings of the variables at six time points (see Table 1). The multilevel logistic regression analysis consisted of two main parts. Models account for all available observations in each time point. The first part examined the overall associations between the independent variables and dependent variables, using a population average logistic regression model. The dependent variables were at-risk

Table 1. Descriptive statistics of the study variables at six time points

Categorical variables		T1		T2		T3		T4		T5		T6	
		n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
At-risk gambling	Yes	126	8	95	8	86	8	71	7	72	8	51	6
At-risk-drinking	Yes	306	20	249	21	208	19	189	19	180	19	167	19
Co-occurrence	Yes	90	6	61	5	58	5	50	5	48	5	40	5
Gender	Female	756	50	590	49	547	50	498	50	462	49	442	50
	Male	770	50	608	51	548	50	506	50	472	50	447	50
Marital status	Married	907	59	720	60	660	60	620	62	559	60	538	61
Unemployment	Unemployed	136	9	89	7	72	7	61	6	54	6	52	6
Debt enforcement	At the moment	142	9	113	8	120	9	110	8	126	9	104	8
High education	At least university	589	39	589	39	589	39	596	39	204	34	213	33
Continuous variables	**Range**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
Age	18–75 (T1)	46.7	16.4	48.9	16.1	49.7	16.1	50.7	15.9	51.9	15.4	53.1	15.3
Income	1–8	3.1	1.6	3.1	1.6	3.2	1.6	3.3	1.6	3.4	1.6	3.4	1.6
Psychological distress	5–30	12.4	4.7	12.2	12.2	12.4	4.5	12.3	4.5	12	4.6	12	4.4
Belonging—friends and family	9–63	48.5	11.7	48	11.8	47.4	11.8	48	12	48.1	11.8	47.8	12.2
Belonging—internet	3–21	8.2	4.7	7.8	4.7	7.9	4.7	7.8	4.6	8	4.7	7.66	4.4
Total. *N*		1530		1198		1095		1004		934		889	

Note. Abbreviations T1—T6, time points 1–6; *n*, number of observations; M, mean; SD, standard deviation.

gambling, at-risk drinking, and their co-occurrence. Three different analyses were conducted for each dependent variable. Since the dependent variables were coded dichotomously, the results of the models are represented in reference to a group of people who scored below the given thresholds. All independent variables were added simultaneously to the models. Analytical weights were used to balance the data, i.e. to correct sampling bias and ensure the correct representation of the population estimates. Average marginal effects (AMEs) were used to enable the comparison between models. The AME values show the average effect of change in one independent variable to the outcome variable while keeping other variables at certain values. Thus, the AME values are not as prone to the effects of other variables enabling comparison (Mize *et al*. 2019; Howell-Moroney 2023). The results of the first analysis are reported in odds ratios and average marginal effects, along with statistical significances, in Table 2.

In the second analysis, we performed a hybrid regression analysis using generalized linear modelling. Since the dependent variables were binary, we fitted the models using the logit link and binomial distribution. Hybrid models provide associations between independent and dependent variables as both within-individual and between-individual effects, using fixed effects and random effect approaches. Hybrid models utilize the information from all 1530 participants who did provide data at any given timepoint (6650 observations in total) and include those data in the analyses, thereby preserving statistical power and reducing the potential bias introduced by excluding participants with missing data. This makes the hybrid models fitting to assess the complex associations between risk factors of addiction for the method's ability to address multiple factors in different ways. We have also provided a sensitivity analysis for at-risk drinking and at-risk gambling focusing solely on respondents who participated in at least five time points (see Appendix).

Our approach gives flexibility to analysis by combining the strengths of fixed- and random-effects approaches. Fixed effects allow unobserved heterogeneity but examines only the within cluster, that is, within individual variation, and only time-variant variables can be used. Examining the association within individuals between different time points enables inferences of possible causality if the associations within individuals are present. Since the reciprocal nature of these associations cannot be considered due lack of control of cross-lagged associations and uncontrolled variables, it is not possible to verify the causality in this analysis (Allison *et al*. 2017). The random effects allow the use of time-invariant variables as well but assume that the observed covariates are not correlated, giving the values based on between-individual comparisons (Schunck and Perales 2017).

The models were run with xthybrid-command (Schunck and Perales 2017), and all the time-varying variables were standardized and re-scaled to a mean of zero to make sure all the variables were evenly distributed. Table 3 presents the results of the hybrid models, displaying the regression coefficients and their corresponding *P*-values for significance levels. The table is separated into within-person effects, illustrating the associations between the independent and dependent variables over time and between-person effects, indicating the associations across individuals.

Results

According to the population average models, results from Table 2, several variables have shown significant associations with at-risk gambling. Age (OR = .84, $P = .048$) and sense of belonging with family and friends (OR = .74, $P < .001$) were found to have negative associations with at-risk gambling. On the other hand, being a man (OR = 1.34, $P < .001$), being in debt enforcement (OR = 1.2, $P = .003$), experiencing psychological distress (OR = 1.24, $P = .002$), and belonging to an online community (OR = 1.28, $P < .001$) were all positively associated with at-risk gambling.

According to the average marginal effects, the strongest factor associated with at-risk gambling was a sense of belonging with family and friends. The second strongest factor was being a man indicating that the probability of at-risk gambling is almost 1.9% higher for men compared to women. On average, for each one-point increase in sense of belonging to an online community score, the probability of being classified as an at-risk gambler increased by 1.6%. Additionally, a one-point increase in psychological distress increased the probability of being an at-risk gambler by 1.5%.

The population average models showed an association between at-risk drinking and age (OR = 0.86, $P = .013$), gender (OR = 1.18, $P = .005$), marital status (OR = 0.89, $P = .027$), income (OR = 1.1, $P = .044$), education (OR = 0.85, $P = .006$), and sense of belonging with family and friends (OR = 1.1, $P = .046$). Average marginal effects showed that being a man, younger age, and having a higher education had the strongest associations with at-risk drinking. Being a man increased the probability of at-risk drinking by 2.5% compared to women.

Table 2. Risk and protective factors for at-risk gambling, at-risk drinking, and their co-occurrence in the population average models

	At-risk gambling		At-risk drinking		Co-occurrence	
	OR	AME	OR	AME	OR	AME
Age	0.84	−0.011*	0.86	−0.023*	0.61	−0.022***
Gender (male)	1.34	0.019***	1.18	0.025**	1.30	0.012*
Marital status (married)	1.04	0.003	0.89	−0.018*	1.03	0.001
Unemployment	0.92	−0.006	1.00	−000	1.03	0.001
Income	0.95	−0.003	1.1	0.15*	1.11	0.005
Debt enforcement	1.20	0.012**	1.06	0.009	1.29	0.011***
High education	0.86	−0.010	0.85	−0.025**	0.71	−0.015**
Psychological distress	1.24	0.015**	1.01	0.002	1.45	0.017***
Belonging—family & friends	0.74	−0.020***	1.11	0.015*	0.89	−0.006
Belonging—internet	1.28	0.016***	1.01	0.001	1.06	0.002
Cons	0.07		0.23		0.04	

Note. * $P \leq .05$ ** $P \leq .01$ *** $P \leq .001$.

Table 3. Hybrid multilevel logistic regression model showing within-person and between-person effects on at-risk gambling, at-risk drinking, and their co-occurrence

	At-risk gambling	At-risk drinking	Co-occurrence
Age	−0.28*	−0.56***	−0.82***
High education		−0.66***	−0.52***
Within-person effects			
Unemployment	0.00	−0.17	0.11
Debt enforcement	0.22	0.41	
Income	−0.25	0.15	−0.62
Psychological distress	0.16	−0.19	1.1***
Belonging—family & friends	−0.24	0.19	0.06
Belonging—internet	0.18	0.15	0.17
Between-person effects			
Unemployment	−0.20	0.49***	0.08
Debt enforcement	0.44***	0.16*	
Income	−0.03	0.57***	0.53***
Psychological distress	0.70***	0.23*	0.75***
Belonging—family & friends	−0.50***	0.26***	−0.41**
Belonging—internet	0.72***	−0.11	0.41***
Constant	−7.44	−10.87	−14.26

Note. *$P \leq .05$ ** $P \leq .01$ *** $P \leq .001$.

Higher age is associated with a lower probability of at-risk drinking by 2.3%. The probability of being an at-risk drinker was decreased by 2.5 for those with higher education.

Regarding co-occurrence, the models showed that age (OR = 0.6, $P < .001$) and high education (OR = 0.71, $P = .003$) were negatively associated with co-occurring at-risk gambling and drinking, while being a man (OR = 1.29, $P = .013$), debt enforcement (OR = 1.29, $P < .001$), and higher psychological distress (OR = 1.45, $P < .001$) were positively associated with co-occurring at-risk gambling and drinking. According to the average marginal effects, age seems to have the strongest association, followed by psychological distress and high education. For a one-point increase in age, the probability of co-occurring at-risk behaviours was decreased by 2.2%. The probability of co-occurring at-risk behaviours increased by 1.7% with a one-point increase in psychological distress and by 1.1% for those in debt enforcement.

The hybrid models (see Table 3) showed that only psychological distress had a within-person effect on co-occurring at-risk gambling and drinking. Moreover, the models highlighted several effects between individuals. The results indicated that debt enforcement, psychological distress, and belonging to an online community were associated with a higher likelihood of being at-risk gamblers. On the other hand, a sense of belonging with friends and family was linked to lower rates of at-risk gambling. Unemployment, debt enforcement, higher income, psychological distress, and a sense of belonging to family and friends were all associated with a greater likelihood of at-risk drinking. Psychological distress, higher income, and belonging to an online community were connected to an increased probability of co-occurring at-risk gambling and drinking. However, a sense of belonging with family and friends was linked to a lower likelihood of co-occurring at-risk gambling and drinking.

Discussion

This study compared the underlying factors of at-risk gambling, at-risk drinking, and their co-occurrence from a longitudinal perspective. Both individual and population levels were examined to identify unique and shared factors in these behaviours. The results showed that younger age and being a man were common factors associated with these at-risk behaviours and their co-occurrence. However, when looking at the average marginal effects, these factors were found to be most significant in explaining at-risk drinking. These findings align with previous research, which has consistently shown that young men are at a higher risk for gambling and drinking problems (Suomi *et al*. 2014; Nordmyr *et al*. 2016; Micu *et al*. 2019; Moreira *et al*. 2023; Dagne *et al*. 2024).

A sense of belonging to an online community was found to be associated solely with at-risk gambling, supporting previous research that has linked online gambling communities with problematic gambling behaviours (Savolainen *et al*. 2022). A sense of belonging to family and friends was found to be associated with both at-risk gambling and at-risk drinking; however, the direction of these relationships was the opposite. Specifically, a sense of belonging to family and friends increased the risk of at-risk drinking but decreased the risk of at-risk gambling. These findings align with previous studies that have shown that being close to family and friends is associated with higher alcohol consumption and lower gambling behaviour (Savolainen *et al*. 2018). These opposing effects may reverse each other when considering both behaviours together, which could explain why there is no association between a sense of belonging to family and friends and the co-occurrence of gambling and drinking at a population level. Differences in the underlying factors behind at-risk behaviours also indicate that social relations contribute to various addictions, but the ways in which they do so might be different between different at-risk behaviours. For instance, consuming alcohol is often viewed as a social activity (Stogner *et al*. 2015), whereas gambling may be more appealing to individuals experiencing loneliness (Edgren *et al*. 2016; Vuorinen *et al*. 2021).

The results also indicated that active debt enforcement and psychological distress were associated with increased at-risk gambling and co-occurrence, but not at-risk drinking. These differences could be explained by the nature of these risky behaviours. Gambling, being an activity centred around money and often leading to financial hardship, may

contribute to the relationship between debt enforcement and at-risk gambling (Muggleton *et al*. 2021). The associations between co-occurrence and debt enforcement suggest that, in addition to possible addiction and distress, there are also financial problems that highlight the multifaceted nature of co-occurrence. Furthermore, these financial difficulties may partially contribute to the psychological distress experienced by gamblers or those with co-occurring issues. Higher education was a protective factor against co-occurrence, which might reflect earlier research showing that academic achievement is associated with a lower risk of substance use in later life (e.g. Kendler *et al*. 2018). One reason is that individuals who succeed academically also have a higher socioeconomic status or better attachment to buffering environments and are more prosocial.

Psychological distress was a central factor explaining addiction in all of the models considering co-occurrence. Psychological distress had a particular within-individual effect on the co-occurrence of at-risk drinking and gambling, suggesting that psychological distress can be considered a predictor of co-occurrence at the individual level. It should also be noted that co-occurring at-risk behaviours can also be the cause of psychological distress, explaining their association at the population level in our model. When considering at-risk drinking, it is possible that the presence of close family and friends may act as a buffer to the mental health of at-risk drinkers, thus reducing psychological distress. However, it is important to note that the results may have differed if a more severe level of drinking had been examined. However, psychological distress could also have mediating effects between co-occurrence of at-risk behaviours and their risk factors explaining its central role. Psychological distress is impactful in almost all areas of life, and one response to it could be engaging in some form of addictive behaviour (Vuorinen *et al*. 2021). Thus, more research on the role of psychological distress in co-occurring at-risk behaviour is needed.

Reflecting on the results in relation to model of addiction by Shaffer et al. (2004), the factors contributing to co-occurrence partly also influence at-risk gambling and drinking. However, only two factors, age and gender, are common to both at-risk behaviours and their co-occurrence. The fact that young men are in bigger risk of at-risk behaviour might stem from low impulse control or high reward sensitivity as a common third factor behind the behaviour. It can be also debated whether the examined underlying factors are causes or consequences of at-risk behaviours. It is possible that some of these factors are symptoms or manifestations of the same underlying addiction syndrome, even if they are not considered actual addictions themselves. Considering the results concerning these underlying factors, the addiction specificity model seems more fitting since not all the underlying factors were shared among the different at-risk behaviours. The differences in underlying factors may help explain why addictions are not always co-occurring, as suggested by the addiction specificity model.

Previous research has highlighted mental health as a central factor in co-occurring addictions (Afifi *et al*. 2016; Allami *et al*. 2018). This aligns with our results on co-occurrence. However, evidence also indicates that gamblers in treatment with a co-occurring alcohol problem score lower on psychological distress (Suomi *et al*. 2014), which could be due to the effects of the treatment or the fact that the relationship between psychological distress and co-occurring addictions is more complex than is currently understood. A comprehensive understanding of the underlying factors of co-occurring problems is crucial to preventing fatalities. People with co-occurring addictions are usually more likely to experience more severe harm due to their addictions (Suomi *et al*. 2014). The evidence provided by this longitudinal research can help develop and target interventions for those individuals who benefit from them the most. The impacts and costs associated with gambling and alcohol-related harms highlight the need for effective prevention strategies (e.g. Ford and Håkansson 2020).

Strengths and limitations

The strength of this study lies in its usage of a population-based longitudinal design, which allowed for the tracking of respondents over a period of 3 years across six time points. This design provided valuable evidence on the factors underlying addiction and co-occurrence. Another major strength of this study is its comparative analysis of at-risk gambling and at-risk drinking, highlighting the need for targeted prevention and intervention strategies that address both shared and unique risk factors. By taking a comprehensive approach, this study supports the development of more effective public health initiatives and policies tailored to the complexities of various addictive behaviours. However, there are some limitations to this study. First, it is restricted to individuals in Finland, which may limit the generalizability of the findings to other populations, and comparative studies across other populations are still needed. Also, as our sample represents the adult population of Finland, the mean age is quite high. It is equally important to investigate drinking and gambling among young people in other longitudinal and cross-national studies. Additionally, the study relies on self-reported data on behaviours that could be considered sensitive, which may introduce bias or inaccuracies. Some of the effect sizes considering the dichotomously categorized variables observed were small. However, even small effect sizes observed over time can add up to notable changes and have meaningful implications. To address these limitations, future research should explore these associations in different cultural contexts and consider alternative assessment methods.

Conclusions

This study examines the risk and protective factors of co-occurring at-risk gambling and drinking over time. Younger age and being a man were identified as shared factors for at-risk gambling, drinking, and their co-occurrence, although these factors were most predictive of at-risk drinking. Marriage was found to be a protective factor, while higher income was associated with increased risk only for at-risk drinking. Belonging to an internet community was identified as a risk factor exclusively for at-risk gambling. Psychological distress emerged as a significant factor for co-occurrence at both the population average and individual levels. Understanding the distinct and shared factors contributing to at-risk gambling and drinking can inform the development of prevention and treatment programs tailored to meet the specific needs of individuals who exhibit these behaviours separately or co-occurring. Prioritizing the identification and reduction of psychological distress, strengthening social relationships, and providing education to young people on avoiding social exclusion may prove effective in addressing these issues.

Author contributions

Sari Hautamäki (Conceptualization, Formal analysis, Writing—original draft [lead], Methodology, Writing—review & editing [equal]), Iina Savolainen (Conceptualization, Data curation, Funding acquisition, Writing—original draft, Writing—review & editing [equal]), Emmi Kauppila (Conceptualization, Writing - original draft, Writing—review & editing [equal]), Anu Sirola (Conceptualization, Writing—original draft, Writing—review & editing [equal]), and Atte Oksanen (Conceptualization, Data curation, Methodology, Supervision [equal], Funding acquisition, Project administration [lead], Writing—original draft, Writing—review & editing [supporting])

Supplementary data

Supplementary data are available at *Alcohol and Alcoholism* online.

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Data availability

The data will be shared on reasonable request to the corresponding author.

Ethics approval

The ethics committee of Tampere region declared in March 2021 that the study does not pose any ethical issues (decision 24/2021).The ethics committee of the Tampere region in Finland declared in their 2021 statements that the protocols for this research did not present any ethical issues (Statements 29/2021 & 115/2022).

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