Original Research

Longitudinal perspective on cryptocurrency trading and increased gambling problems: a 3 wave national survey study

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ABSTRACT

Objectives: Cryptocurrency trading has gained popularity over the last few years. Trading is facilitated by online platforms that enable 24/7 trading. Cryptocurrency trading is potentially attractive to gamblers, and it may increase their gambling problems. Furthermore, cryptocurrency trading might be a particularly harmful activity for those gambling offshore. We investigated whether cryptocurrency trading predicts excessive gambling over time. We also analyzed how cryptocurrency trading combined with offshore gambling is associated with excessive gambling.

Study design: This was a population-based longitudinal survey study.

Methods: We surveyed a sample of Finnish people aged 18–75 years (N = 1022, 51.27% male) at three time points in 6-month intervals: April 2021 (T1), October to November 2021 (T2), and April to May 2022 (T3). Of the original T1 respondents, 66.80% took part in T2 and T3. Outcome measure was excessive gambling using the Problem Gambling Severity Index, and the predictor was cryptocurrency trading. We adjusted models for onshore and offshore gambling online, excessive gaming (Internet Gaming Disorder Test), excessive internet use (Compulsive Internet Use Scale), excessive alcohol use (Alcohol Use Disorders Identification Test), and sociodemographic background factors. We used multilevel regression models to investigate within-person and between-person effects.

Results: Cryptocurrency trading has increased in popularity over time. Within-person changes in cryptocurrency trading predicted increased excessive gambling. Excessive gambling was also generally more common among cryptocurrency traders. The full model that was adjusted for the number of confounding factors showed that cryptocurrency trading had a within-person effect on excessive gambling. Of the confounding factors, offshore online gambling, excessive gaming, and excessive internet use had within-person effects on excessive gambling. Offshore and onshore online gamblers and excessive gamers showed more excessive gambling than others. Those participants who were both cryptocurrency traders and offshore gamblers showed significantly higher rate of excessive gambling than others.

Conclusions: Cryptocurrency trading is a risky activity and associated with a higher rate of excessive gambling over time. Such activity is especially risky among offshore online gamblers, who could view cryptocurrency trading as another form of gambling or as a way to make money for gambling. Policymakers and counselors should be aware of the risks of cryptocurrency trading.

Introduction

Cryptocurrency trading has received increasing attention over the past few years. Various global companies have created platforms that make cryptocurrency trading easily accessible and convenient. These services and platforms are currently widely marketed not only online but also at major sporting events.[1] For example, crypto.com became an official partner of Formula 1 in 2022. At the same time, 2022 has shown the volatility of cryptocurrency trading with the complete collapse of stablecoin TerraUSD in May.

Cryptocurrency trading is based on blockchain technology,[2] a distributed ledger that allows for real-time peer-to-peer operations, through which people can buy and sell virtual currencies any time of the day.[3] Bitcoin is the most well-known cryptocurrency, but thousands of cryptocurrencies are currently on the market.[4] Cryptocurrency trading has caused concerns among policymakers because of its risks, including high volatility, cybersecurity, and lack of regulation, which may be attractive to, for example, criminal groups.[5]

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The cryptocurrency market's high volatility, fast-paced environment, focus on short-term gains, and high risks are among factors that have led cryptocurrency trading to be considered an online gambling-like activity in academic literature.[3,6] Whereas previous research has shown that excessive day trading and stock market trading is related to problem gambling,[7–9] researchers have analyzed the associations and similarities of cryptotrading and gambling in fewer recent studies. Mills and Nower found that trading cryptocurrencies was strongly associated with excessive gambling.[6] Oksanen et al. found that cryptocurrency trading was associated with excessive gambling (i.e. gambling problems), excessive gaming, and excessive internet use.[9] Cryptocurrency traders are likely motivated by novelty and risk-seeking behavior and influenced by prior investing patterns.[10,11] However, longitudinal research is necessary to analyze cryptocurrency trading's potentially growing impact on gambling problems.

Previous studies have suggested that people found trading platforms while at home at the beginning of the COVID-19 pandemic in 2020.[12,13] At the same time, regular gambling activities were lacking due to lockdowns and the resultant lack of sporting events.[14] Gamblers might have moved to speculative trading markets at this point. According to a cross-national study, investing during COVID-19 increased the most in countries that produced more gambling opportunities.[15] It is equally likely that due to the COVID-19 pandemic, many gamblers moved to online gambling sites that did not suffer from lockdowns. It is therefore very important to analyze cryptocurrency trading in the context of online gambling in general.

The rapid rise of online gambling has made offshore gambling sites available to anyone interested.[16,17] Offshore gambling refers to operators who do not hold valid licenses in given jurisdictional areas but provide gambling services to customers in that area against the local restrictions, thus providing gamblers a way to circumvent these restrictions and conceal their gambling. In previous studies, offshore gambling has been associated with more severe gambling problems than gambling on licensed onshore sites.[16,17] Offshore gambling sites can be tempting for many, as they are often heavily advertised with high payout rates, benefits and bonuses, and the ability to use local currency.[17] At the same time, they pose a risk of excessive gambling with their almost unlimited selection of potentially high-risk gambling options with little regulation. Given the similarities between online gambling and cryptocurrency trading, cryptocurrency trading can serve as an attractive expansion of monetary activities for those engaged in offshore gambling. Moreover, cryptocurrency traders and offshore gamblers share similar demographic characteristics, such as being male and young.[3,6,9,18,19]

We investigated whether cryptocurrency trading predicts gambling problems over time. We were mostly interested in the changes over time within individuals (i.e. within-person change). This is the first longitudinal study to investigate the role of cryptocurrency trading in excessive gambling. Our research questions were the following:

1) Does cryptocurrency trading predict excessive gambling over time?
2) How is cryptocurrency trading combined with offshore gambling associated with excessive gambling?

Methods

Participants and procedure

This study is based on longitudinal *Gambling in the Digital Age* survey. We surveyed a sample of Finnish speakers in mainland Finland. They were aged 18–75 years ($N = 1022$; 51.27% male, 48.43% female, and 0.03% other gender). We collected the data at three points in 6-month intervals: April 2021 (T1), October–November 2021 (T2), and April–May 2022 (T3). Of the original T1 respondents, 66.80% took part in T2 and T3. The participants represented all areas of mainland Finland, and 36.30% were from the Helsinki-Uusimaa region, 20.25% from Southern Finland, 24.27% from Western Finland, and 19.18% from Northern and Eastern Finland.

Non-response analysis between those who responded at all three points ($N = 1022$) and the original T1 respondents ($N = 1530$) showed that the respondents in the final sample were, on average, older (49.50 years vs 46.67 years). No major dropout occurred based on gender, geographical area, income, education, marital status, or occupational status, but the mean rate of excessive gambling based on the Problem Gambling Severity Index (PGSI) was lower in the final sample than in T1 (1.15 vs 1.31). Considering that our sample in T1 included more gamblers than some estimations in the general population,[20] our final sample is closer to these estimations. The final data do not include any major biases, compared with the general population, based on population census figures by Statistics Finland.[21]

After each phase of data collection, we reviewed the data in accordance with the data quality protocol of the project that was stored on the Open Science Framework website before data collection. Integrity and quality checks on the data included attention checks, patterned-response checks, rapid-response checks, and non-sensical-response checks.[22,23] We also checked the open-ended comments that some of the participants gave after the survey to evaluate potentially biased motives to respond or other potential problems with the survey.

The Academic Ethics Committee of the Tampere region approved the study in March 2021. Participation was voluntary, and we informed the participants about the aims of the study. The study also complies with the European Code of Conduct for Research Integrity, the General Data Protection Regulation of European Union, and fundamental ethics principles, including those reflected in the Charter of Fundamental Rights of the European Union.

Measures

As the dependent variable for our study, we used the PGSI, which is a widely used general population screener for excessive gambling.[24–26] We asked respondents about their gambling problems during the previous 6 months (e.g. "Have you felt guilty about the way you gamble or what happens when you gamble?"). The response choices were 0 (*never*), 1 (*sometimes*), 2 (*most of the time*), and 3 (*almost always*). Higher PGSI scores indicate more severe excessive gambling. The scale had excellent internal consistency at all points, as measured with McDonald's omega (T1: $\omega = 0.94$, T2: $\omega = 0.93$, T3: $\omega = 0.94$).

Cryptocurrency trading was the main independent variable. We asked about cryptocurrency trading in a pattern of questions on activities taken place during the past 6 months. The question was, "How often have you traded in crypto markets (e.g., Binance, Bit-Panda)?" We created a dummy variable for those who had traded in crypto markets within the previous 6 months (0 = no, 1 = yes).

We measured onshore and offshore online gambling in a larger pattern about activities during the past 6 months. The question on onshore online gambling concerned the gambling monopoly Veikkaus site. Regarding offshore online gambling sites, we asked about "gambling in offshore online gambling sites (other than Veikkaus or Paf)." For both measures, we created dummy variables indicating those gambling in onshore and offshore online sites during the past 6 months (0 = no, 1 = yes).

As a measure for excessive gaming, we used the 10-item Internet Gaming Disorder Test,[27] which contains statements about excessive behaviors in gaming (e.g. "How often have you felt

restless, irritable, anxious and/or sad when you were unable to play or played less than usual?"). We were interested in the previous 6 months. Answer choices were 0 (*never*), 1 (*sometimes*), and 2 (*often*). Higher Internet Gaming Disorder Test scores indicated more severe excessive gaming. The scale had good internal consistency, ranging from good to excellent (T1: $\omega = 0.88$, T2: $\omega = 0.90$, T3: $\omega = 0.88$).

We used the Compulsive Internet Use Scale (CIUS) to measure excessive internet use.[28] The CIUS includes 14 items and has been widely used in studies on excessive, problematic, or addictive internet use.[29,30] Similar to other screeners of excessive behavior, it measures withdrawal, loss of control, continued use despite negative consequences, guilt, and negative comments from close ones (e.g. "do others (e.g., friends, parents, partner) say you should use the internet less?"). The participants responded on a scale from 0 (*never*) to 4 (*very often*). Higher CIUS scores indicate more severe excessive internet use. The scale had excellent internal consistency at all points (T1: $\omega = 0.95$, T2: $\omega = 0.95$, T3: $\omega = 0.95$).

To measure excessive alcohol use, we used the Alcohol Use Disorders Identification Test, which is a widely used three-item screener for excessive drinking.[31,32] The three items measure frequency of drinking, heavy drinking, and units per drinking occasion, and response options range from 0 to 4. Higher Alcohol Use Disorders Identification Test scores indicate a higher risk for excessive drinking. The scale showed good internal consistency at all points (T1: $\omega = 0.82$, T2: $\omega = 0.83$, T3: $\omega = 0.84$).

To measure psychological distress, we used the 5-item Mental Health Inventory, which is a short version of the original long inventory, and it includes items on mood, such as positive affect, emotional control, depression, and anxiety (e.g. "How much of the time, during the last month, have you felt downhearted and blue?").[33] The 5-item Mental Health Inventory is considered a valid screener of mood disorders in the general population.[34–36] Response options range from 1 (*none of the time*) to 6 (*all of the time*), and we reverse coded two of the items on positive affect. The measure had good internal consistency at all points (T1: $\omega = 0.89$, T2: $\omega = 0.88$, T3: $\omega = 0.87$).

Background information included sociodemographic variables that we treated as controls. We created a dummy variable for age, indicating 40 years or older (69.37%). For male gender, we created a dummy variable (51.27% of the participants). We grouped participants who chose "other" gender (n = 3) together with those who chose "female." We categorized education on the basis of having at least a science university degree (i.e. typically master's degree, 21.72%) and high income on the basis of at least 4000 euros income per month (17.03%). We also created a dummy variable for those married or in a registered relationship (59.78%) and for those who were working as employed, self-employed, or with scholarship (51.57%).

Statistical analyses

We conducted statistical analyses using Stata 17 software. We report short descriptive findings followed by the main analyses, focusing on the relationship between cryptocurrency trading and excessive gambling. The linear multilevel hybrid models had excessive gambling as a dependent variable, and we were mainly interested in cryptocurrency trading's effects on excessive gambling over time. Hybrid models allow for the estimation of within-person effects and between-person effects simultaneously in the same model, and they thus combined the strengths of random-effect and fixed-effect approaches and solved their shortcomings.[37,38] We ran these models with xthybrid command in Stata.[38] Within-person effects indicate how changes in time-variant independent variables are associated with changes in the time-variant dependent variable. Between-person variables show group differences between individuals.

The models also included several within-person and between-person control variables. For example, our model controlled for onshore and offshore online gambling and accounted for excessive drinking, gaming, and internet use and psychological distress. Adjustments of these factors gave us better grounds to claim that the main independent variable of interest has an effect on the dependent variable. As this is a longitudinal study, our main point of interest was only the within-person effect of cryptocurrency trading on excessive gambling. We report regression coefficients (B) and their standard errors, 95% confidence intervals (95% CIs), Z values, and *P*-values for statistical significance.

Our additional analyses focused on the interaction between cryptocurrency trading and onshore and offshore online gambling. We conducted these analyses using multilevel linear mixed-effects regression in Stata. This model had robust Huber-White standard errors and an unstructured covariance structure for random intercepts and slopes. We adjusted the model for the same control and sociodemographic variables as in the main hybrid models. We present plotted predictive margins in figure.

Results

In T1, 5.28% of the participants were trading cryptocurrencies. Cryptocurrency trading had increased in popularity over time, as in T2, 6.26% of participants were trading cryptocurrencies and 7.34% in T3 (see Table 1). The fixed-effects change of cryptocurrency trading over time was statistically significant between T1 and T3 ($P = 0.004$). Onshore and offshore online gambling did not increase from T1 to T3, and none of the changes over time were statistically significant.

We ran the first hybrid models including cryptocurrency trading as an independent variable and age and male gender as controls. The results show that cryptocurrency trading had a within-person effect (B = 1.22, 95% CI = 0.47, 1.97, Z = 3.17, $P = 0.002$) and a between-person effect (B = 3.32, 95% CI = 1.69, 4.94, Z = 3.99, $P < 0.001$) on excessive gambling. These results show that increases in cryptocurrency trading are associated with increases in PGSI scores for excessive gambling (within-person effect). Furthermore, cryptocurrency traders had higher average PGSI scores than those not trading cryptocurrencies (between-person effect).

Table 2 presents our full models. They show that after we adjusted a number of confounding factors, cryptocurrency trading's within-person effect on excessive gambling was statistically significant (B = 0.94, 95% CI = 0.35, 1.52, Z = 3.13, $P = 0.002$). Cryptocurrency trading's between-person effect was no longer statistically significant. This is explained by number of stronger between-person predictors. Regarding control variables, offshore online gambling and excessive gaming had within-person and between-person effects on excessive gambling. Excessive internet use had a within-person effect and onshore online gambling a between-person effect on excessive gambling.

The last part of our analysis focused on the potential role of offshore online gambling. We found out that among offshore gamblers, many traded cryptocurrencies, and the proportion increased over time. In T1, 19.08% of offshore gamblers traded cryptocurrencies; in T2, 24.49%; and in T3, 28.06%. Relatively few onshore gamblers traded cryptocurrencies: 7.09% in T1, 8.20% in T2, and 9.95% in T3. Our multilevel linear mixed-effect model focused on interactions of onshore and offshore online gambling with cryptocurrency trading. We found that offshore online gambling and cryptocurrency trading interacted, indicating that excessive gambling is particularly strong among cryptocurrency traders who gamble offshore (see Fig. 1).

Table 1
Descriptive statistics of main study variables.

Continuous variables	Range	T1, M (SD)	T2, M (SD)	T3, M (SD)	Zero order correlations at T1						
					1	2	3	4	5	6	7
1. Excessive gambling	0–25	1.15 (3.02)	1.12 (2.98)	1.11 (3.04)	1						
2. Excessive gaming	0–16	1.12 (2.36)	1.24 (2.52)	1.10 (2.28)	0.53***	1					
3. Excessive internet use	0–52	7.95 (9.06)	8.20 (9.65)	7.85 (9.31)	0.32***	0.49***	1				
4. Excessive drinking	0–12	3.54 (2.71)	3.46 (2.73)	3.42 (2.72)	0.17***	0.08*	0.03	1			
5. Distress	5–30	12.24 (4.67)	12.20 (4.58)	12.28 (4.43)	0.24***	0.31***	0.43***	0.07*	1		
Categorical variables	Coding	T1, % yes	T2, % yes	T3, % yes							
6. Cryptocurrency trading	0/1	5.28%	6.26%	7.34%	0.22***	0.21***	0.17***	0.0499	0.12***	1	
7. Onshore online gambling	0/1	63.50%	62.04%	61.94%	0.23***	0.11***	0.02	0.16***	0.03	0.11***	1
8. Offshore online gambling	0/1	14.87%	14.38%	13.60%	0.47***	0.26***	0.11***	0.21***	0.13***	0.26***	0.27***

Note. ***$P < 0.001$, *$P < 0.05$.

Discussion

We investigated whether cryptocurrency trading predicts excessive gambling over time. We also analyzed how cryptocurrency trading combined with offshore gambling is associated with excessive gambling. We found that cryptocurrency trading had increased its popularity a bit over time in our sample. Cryptocurrency trading had a robust within-person effect on excessive gambling in all our models. Considering that we adjusted our model for the number of confounding factors, cryptocurrency trading is likely increasing excessive gambling.

Previous studies have not included longitudinal data, but our results are in line with general notions produced by the previous research.[6,9] Cryptocurrency trading is a highly speculative activity, and major winnings promised by the sites are potentially attractive to users. Given the potential fast and large gains, high-risk cryptocurrency traders may make fast-paced transactions that do not nurture a growing investment over time but are instead similar to action-oriented gambling and characterized by chasing and feelings of rush.[6] It is also conceivable that options to use high leverage for trading are very attractive to those who already have existing gambling problems. Our results show that an increase over time in cryptocurrency trading is associated with increases in excessive gambling.

Our results also showed that offshore online gambling had strong within-person and between-person effects on excessive gambling, which shows that not only those who gamble offshore report stronger excessive gambling but the increase in offshore gambling over time is associated with an increase in excessive gambling. The potential harms of offshore gambling are currently widely discussed.[15,16] Our results provide new longitudinal evidence of the phenomenon and demonstrate that offshore online gambling is a more significant risk factor in excessive gambling than regulated onshore online gambling.

The combination of offshore gambling and cryptocurrency trading was clearly associated with more severe gambling problems in our results. We believe this result is important as cryptocurrency traders are likely attracted to offshore online gambling sites and offshore online gamblers to cryptocurrency trading activities. Some online operators even take bets on cryptocurrencies, which may encourage gamblers to explore new forms of cryptocurrency trading. These types of expanded gambling and trading opportunities highlight the shortcomings of online gambling operators to provide a certain level of safety for their users and ways

Table 2
Hybrid models showing within-person and between-person effects on excessive gambling.

|	Full model				
	B	SE (B)	95% CI	Z	P
Within-person effects					
Cryptocurrency trading	0.94	0.30	0.35 to 1.52	3.13	0.002
Onshore online gambling	0.04	0.08	−0.12 to 0.20	0.49	0.625
Offshore online gambling	0.65	0.20	0.26 to 1.05	3.24	0.001
Excessive gaming	0.27	0.05	0.17 to 0.37	5.36	<0.001
Excessive internet use	0.05	0.01	0.03 to 0.07	4.49	<0.001
Excessive drinking	0.08	0.04	−0.01 to 0.16	1.83	0.067
Distress	0.00	0.01	−0.02 to 0.02	0.05	0.961
Between-person effects					
Cryptocurrency trading	0.32	0.50	−0.67 to 1.30	0.64	0.525
Onshore gambling online	0.51	0.11	0.30 to 0.72	4.80	<0.001
Offshore gambling online	3.49	0.44	2.62 to 4.36	7.84	<0.001
Excessive gaming	0.51	0.08	0.35 to 0.67	6.35	<0.001
Excessive internet use	0.02	0.01	−0.01 to 0.05	1.37	0.170
Excessive drinking	0.05	0.03	−0.01 to 0.11	1.65	0.100
Distress	0.02	0.02	−0.01 to 0.06	1.26	0.208
Controls					
Age ≥40 years	0.53	0.18	0.18 to 0.88	2.97	0.003
Male	−0.26	0.14	−0.53 to 0.02	−1.83	0.067
University degree	−0.15	0.13	−0.40 to 0.11	−1.12	0.261
High income	−0.09	0.19	−0.46 to 0.27	−0.49	0.626
In official relationship	−0.10	0.14	−0.38 to 0.18	−0.69	0.491
Working	−0.05	0.13	−0.31 to 0.20	−0.40	0.690

CI, confidence interval.
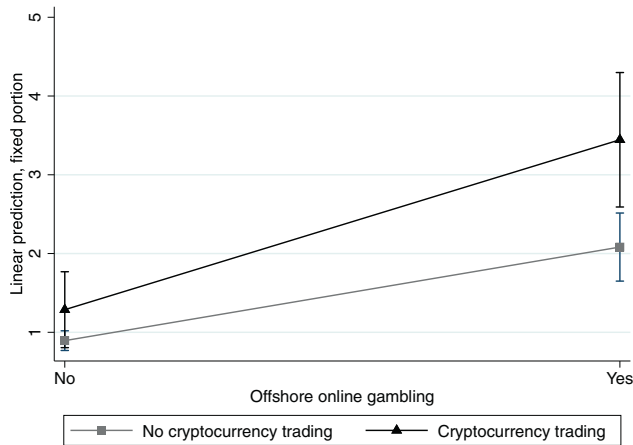
Fig. 1. Excessive gambling among those who trade cryptocurrencies and gamble offshore.

to moderate their gambling, and call for safer gambling and consumer protection practices.[39] There are also indications that as the marketing of traditional gambling has been banned in professional sports, the advertising of cryptocurrency trading and financial trading apps has increased.[1] As the online environment makes it easier to become involved in various types of risky behaviors and conceal them from others, it is possible that the occurrence of more severe gambling and other problems also increases. These trends involving offshore online gambling and cryptocurrency trading should be researched and monitored closely in future as they represent a fast-changing area and, as such, a challenge for legislators and policymakers to keep up with.

Limitations and strengths

We limited this study to participants from Finland, so future researchers could investigate the observed associations in cross-cultural contexts. Our study is also limited by self-reported measures, as the results were based on the participants' perceptions and evaluation of themselves. Similarly, as participation was voluntary, it may have been influenced by participants' personal interest in the topic. The study's strengths include longitudinal sample and low dropout rate. This is also the first longitudinal study to investigate cryptocurrency trading's effect on excessive gambling.

Conclusion

The results of this three-wave longitudinal study show that cryptocurrency trading predicts excessive gambling. Cryptocurrency trading combined with offshore online gambling was associated with more severe excessive gambling. Our results imply that cryptocurrency trading should be considered a very risky activity for online gamblers. Cryptocurrency trading itself is highly speculative activity, but it is marketed aggressively to consumers despite the risks. Existing problems with gambling are likely to increase with cryptocurrency trading. Policymakers and councilors should be aware of the risks of cryptocurrency trading.

Author statements

References

1. Newall PWS, Xiao LY. Gambling marketing bans in professional sports neglect the risks posed by financial trading apps and cryptocurrencies. *Gaming Law Rev* 2021;**25**(9):376. 37.
2. Tijan E, Aksentijević S, Ivanić K, Jardas M. Blockchain technology implementation in logistics. *Sustainability* 2019;**11**(4):1185.
3. Delfabbro P, King D, Williams J, Georgiou N. Cryptocurrency trading, gambling and problem gambling. *Addict Behav* 2021;**122**:107021.
4. Härdle WK, Harvey CR, Reule RC. Understanding cryptocurrencies. *J Financ Econ* 2020;**18**(2):181—208.
5. Fang F, Ventre C, Basios M, Kanthan L, Martinez-Rego D, Wu F, et al. Cryptocurrency trading: a comprehensive survey. *Finan Innov* 2022;**8**(1):1—59.
6. Mills DJ, Nower L. Preliminary findings on cryptocurrency trading among regular gamblers: a new risk for problem gambling? *Addict Behav* 2019;**92**: 136—40.
7. Grall-Bronnec M, Sauvaget A, Boutin C, Bulteau S, Jiménez-Murcia S, Fernández-Aranda F, et al. Excessive trading, a gambling disorder in its own right? A case study on a French disordered gamblers cohort. *Addict Behav* 2017;**64**: 340—8.
8. Mosenhauer M, Newall PWS, Walasek L. The stock market as a casino: associations between stock market trading frequency and problem gambling. *J Behav Addict* 2021;**10**(3):683—9.
9. Oksanen A, Mantere E, Vuorinen I, Savolainen I. Gambling and online trading: emerging risks of real-time stock and cryptocurrency trading platforms. *Publ Health* 2022;**205**:72—8. https://doi.org/10.1016/j.puhe.2022.01.027.
10. Kim HJ, Hong JS, Hwang HC, Kim SM, Han DH. Comparison of psychological status and investment style between bitcoin investors and share investors. *Front Psychol* 2020;**11**:502295.
11. Pelster M, Breitmayer B, Hasso T. Are cryptocurrency traders pioneers or just risk-seekers? Evidence from brokerage accounts. *Econ Lett* 2019;**182**:98—100.
12. Guzmán A, Pinto-Gutiérrez C, Trujillo MA. Trading cryptocurrencies as a pandemic pastime: COVID-19 lockdowns and bitcoin volume. *Mathematics* 2021;**9**.
13. Pagano MS, Sedunov J, Velthuis R. How did retail investors respond to the COVID-19 pandemic? The effect of Robinhood brokerage customers on market quality. *Finance Res Lett* 2021;**43**:101946.
14. Håkansson A. Changes in gambling behavior during the COVID-19 pandemic — a web survey study in Sweden. *Int J Environ Res Publ Health* 2020;**17**.
15. Chiah M, Zhong A. Trading from home: the impact of COVID-19 on trading volume around the world. *Finance Res Lett* 2020;**37**:101784.
16. Hing N, Russell AMT, Browne M, Rockloff M, Greer N, Rawat V, et al. The second national study of interactive gambling in Australia (2019-20). Sydney, NSW: Gambling Research Australia.
17. Gainsbury SM, Abarbanel B, Blaszczynski A. Factors influencing internet gamblers' use of offshore online gambling sites: policy implications. *Pol Internet* 2019;**11**(2):235—53.
18. Costes JM, Kairouz S, Eroukmanoff V, Monson E. Gambling patterns and problems of gamblers on licensed and unlicensed sites in France. *J Gambl Stud* 2016;**32**(1):79—91. 2016.
19. Gainsbury SM, Russell AMT, Hing N, Blaszczynski A. Consumer engagement with and perceptions of offshore online gambling sites. *New Media Soc* 2018;**20**(8):2990—3010.
20. Salonen A, Lind K, Hagfors H, Castrén S, Kontto J. *Rahapelaaminen, peliongelmat ja rahapelaamiseen liittyvät asenteet ja mielipiteet vuosina 2007—2019. Raportti 18/2020.* Helsinki: Finnish Institute for Health & Welfare; 2020 [cited 2 July 2022]. Available from: https://urn.fi/URN:ISBN:978-952-343-594-0.
21. Statistics Finland. *StatFin Online service for population census figures.* 2022 [cited 2 July 2022]. Available from: https://www.stat.fi/tup/statfin/index_en.html.
22. Curran PG. Methods for the detection of carelessly invalid responses in survey data. *J Exp Soc Psychol* 2016;**66**:4—19.

23. Pickering D, Blaszczynski A. Paid online convenience samples in gambling studies: questionable data quality. *Int Gambl Stud* 2021;**21**:516–36.
24. Ferris J, Wynne H. *The Canadian problem gambling Index: final report*. Ottawa: Canadian Centre on Substance Abuse; 2001 [cited 2 July 2022]. Available from: https://www.greo.ca/Modules/EvidenceCentre/files/Ferris%20et%20al(2001) The_Canadian_Problem_Gambling_Index.pdf.
25. Holtgraves T. Evaluating the problem gambling severity index. *J Gambl Stud* 2009;**25**:105–20.
26. Raisamo SU, Mäkelä P, Salonen AH, Lintonen TP. The extent and distribution of gambling harm in Finland as assessed by the Problem Gambling Severity Index. *Eur J Publ Health* 2015;**25**:716–22.
27. Király O, Sleczka P, Pontes HM, Urbán R, Griffiths MD, Demetrovics Z. Validation of the ten-item internet gaming disorder test (IGDT-10) and evaluation of the nine DSM-5 internet gaming disorder criteria. *Addict Behav* 2017;**64**: 253–60.
28. Meerkerk GJ, Van Den Eijnden RJ, Vermulst AA, Garretsen HF. The compulsive internet use scale (CIUS): some psychometric properties. *Cyberpsychol Behav* 2009;**12**:1–6.
29. Guertler D, Rumpf HJ, Bischof A, Kastirke N, Petersen KU, John U, et al. Assessment of problematic internet use by the compulsive internet use scale and the internet addiction test: a sample of problematic and pathological gamblers. *Eur Addiction Res* 2014;**20**:75–81.
30. Zych I, Kaakinen M, Savolainen I, Sirola A, Paek HJ, Oksanen A. *The role of impulsivity, social relations online and offline, and compulsive Internet use in cyberaggression: a four-country study*. New Media & Society; 2021. 14614448211009459.
31. Babor TF, Higgins-Biddle JC, Saunders JB, Monteiro MG. *AUDIT: the alcohol use disorders identification test: guidelines for use in primary health care*. 2nd ed.

Geneva: WHO; 2001 [cited 2 July 2022]. Available from: https://www.who.int/ publications/i/item/audit-the-alcohol-use-disorders-identification-test-guidelines-for-use-in-primary-health-care.
32. Kaarne T, Aalto M, Kuokkanen M, Seppa K. AUDIT-C, AUDIT-3 and AUDIT-QF in screening risky drinking among Finnish occupational health-care patients. *Drug Alcohol Rev* 2010;**29**:563–7.
33. Berwick DM, Murphy JM, Goldman PA, Ware Jr JE, Barsky AJ, Weinstein MC. Performance of a five-item mental health screening test. *Med Care* 1991;**29**:169–76.
34. Cuijpers P, Smits N, Donker T, ten Have M, de Graaf R. Screening for mood and anxiety disorders with the five-item, the three-item, and the two-item Mental Health Inventory. *Psychiatr Res* 2009;**168**:250–5.
35. Rumpf HJ, Meyer C, Hapke U, John U. Screening for mental health: validity of the MHI-5 using DSM-IV Axis I psychiatric disorders as gold standard. *Psychiatr Res* 2001;**105**:243–53.
36. Thorsen SV, Rugulies R, Hjarsbech PU, Bjorner JB. The predictive value of mental health for long-term sickness absence: the Major Depression Inventory (MDI) and the Mental Health Inventory (MHI-5) compared. *BMC Med Res Methodol* 2013;**13**:1–7.
37. Schunck R. Within and between estimates in random-effects models: advantages and drawbacks of correlated random effects and hybrid models. *STATA J* 2013;**13**(1):65–76. https://doi.org/10.1177/1536867X1301300105.
38. Schunck R, Perales F. Within- and between-cluster effects in generalized linear mixed models: a discussion of approaches and the xthybrid command. *STATA J* 2017;**17**(1):89–115. https://doi.org/10.1177/1536867X1701700106.
39. Andrade M, Sharman S, Xiao LY, Newall PWS. *Safer gambling and consumer protection failings amongst 40 frequently visited cryptocurrency-based online gambling operators*. Available at: https://psyarxiv.com/fgxrb. [Accessed 31 August 2022].