Original Article

Development of the Cryptocurrency Addiction Scale: A Methodological Study

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Abstract
Background: Cryptocurrency addiction is a new type of behavioral addiction that should be urgently addressed by professionals within the public mental health context. Therefore, a psychometrically sound measurement tool is urgently needed.
Objectives: This study aimed to develop a 'cryptocurrency addiction scale'.
Design: A descriptive, cross-sectional, and methodological design.
Setting: Turkey.
Participants: A total of 279 Turkish people participated in the first stage and 289 people participated in the second stage of the study.
Methods: Exploratory and confirmatory factor analyses were used to test construct validity. To test criterion-related validity, Pearson's correlation coefficients between the Cryptocurrency Addiction Scale and the Generalized Problematic Internet Use Scale 2, De Jong Gierveld Loneliness Scale, and Epworth Sleepiness Scale were investigated. Internal reliability was assessed using Cronbach's α and McDonald's ω. Test-retest reliability was tested using Pearson's correlation between these two measures.
Results: Exploratory factor analysis resulted in the extraction of six factors (conflict, tolerance, relapse, withdrawal, mood modification, and salience), which explained 63.41% of the total variance. The first- and second-order confirmatory factor analysis models showed good model fit. Participants' scores on the Cryptocurrency Addiction Scale showed significant positive correlations with problematic Internet use, loneliness, and sleepiness scores. Cronbach's α and McDonald's ω reliability coefficients of the scale were 0.93. A significant positive correlation was found between the test and retest scores of the scale.
Conclusion: The Cryptocurrency Addiction Scale showed good construct validity, criterion-related validity, internal reliability, and test-retest reliability. Validity and reliability studies of the Cryptocurrency Addiction Scale in other languages are recommended.

Keywords: Addiction; Cryptocurrency; Gambling; Internet use; Loneliness; Psychometrics; Sleep.

Introduction

Behavioural addictions

The term 'addiction' means much more than just the process which starts with the intake of a psychoactive substance. The idea that people can also develop addiction to a specific behavior has gained ground in the literature. Thus, the latest edition of Diagnostic and Statistical Manual of Mental Disorders (DSM-5) recognizes gambling disorder as a behavioral addiction, and Internet gaming disorder is listed as another potential behavioral addiction in Section III of the DSM-5 (American Psychiatric Association, 2013). The number of studies investigating other potential behavioral addictions, such as video gaming, eating, sex, cell phone use, exercise, Internet use, shopping, social media use, and work addiction, has been increasing (Gomez et al., 2022). Therefore, it is possible that there are various behaviors that can lead to addiction.

Cryptocurrency addiction and mental health

Cryptocurrency addiction – another type of behavioral addiction – has attracted the attention of researchers in recent years (Griffiths, 2018; Mills and Nower, 2019). Cryptocurrency is a digital currency created with limited supply and exchanged on digital computer systems and is not regulated by any bank or government (Mills and Nower, 2019). Cryptocurrencies are system-based digital assets designed to be used as virtual exchange tools which can be used for many purposes in the economic coordination mechanisms of blockchain systems (such as decentralized finance) (Johnson et al., 2023). Cryptocurrencies are decentralized; that is, they can be transacted peer-to-peer without a centralized administrator. Transactions are encrypted and stored in a distributed database known as a blockchain (Steinmetz, 2023). The contents of a blockchain are replicated end-to-end by multiple users who collectively manage and secure the blockchain, which allows decentralized control and keeping of records.

Interest in cryptocurrencies has been proven by the global market value rising to approximately USD 3 trillion in 2021. There has been much interest in cryptocurrencies because of their superior performance compared to other investment tools. While the value of one Bitcoin was almost USD 1,000 in 2017, it shot up to record levels of approximately USD 68,000 in 2021 (Coinmarketcap, 2022). While the number of cryptocurrency types that were on offer during the first years of cryptocurrencies was not more than the fingers on one hand; now, according to Coinmarketcap, – one of the biggest cryptocurrency markets – there are 21,662 types of cryptocurrency (Coinmarketcap, 2022).

Round-the-clock nature of cryptocurrency trading, easy access to cryptocurrency markets and mobile trading applications, and availability of leveraged transactions can be other reasons why cryptocurrencies appeal to their users (Johnson et al., 2023). Oksanen et al. (2022) suggest that lockdowns and lack of betting opportunities such as sport matches during the COVID-19 pandemic could have increased the interest in cryptocurrencies.

Kim et al. (2020) reported that cryptocurrency investors are younger, are irrationally optimistic that they can build wealth easily, have higher risk-taking behavior (or are sensation-seeking), and experience fear of missing out (FoMO) psychology compared to other investors. However, the volatile and speculative pricing of cryptocurrency assets can result in risk of high-level economic loss, even for long-term investors. For example, in 2022, there was over 70% fall from the highest levels in November 2021 (CoinMarketCap, 2022). Significant economic loss is associated with negative mental health outcomes such as depression and anxiety (Engelberg & Parsons, 2016). Therefore, cryptocurrency addiction should be addressed as an important public health concern.

Griffiths (2018), who has published many papers on behavioral addiction, considers 'cryptocurrency addiction' a form of gambling addiction. Griffiths suggested that cryptocurrency addiction is a subtype of daily online trading addiction and/or stock market trading addiction. A situation in which highly volatile assets are traded and dubious but high profits are hoped is similar to the basics of gambling (Delfabbro et al., 2021).

According to Mills and Nower (2019), the hope for higher profits explains the relationship between cryptocurrency trading and problem gambling. According to a study conducted by the Financial Conduct Authority (FCA, 2019) in the UK on 2132 British volunteers, people buy cryptocurrencies mostly to gamble (31%), differentiate their portfolio (30%), and make money quickly.

A literature review suggests that day trading can be associated with gambling (Delfabbro et al., 2021) and, contrary to trading, 'investing' is different from gambling (Johnson et al., 2023). However, it is not possible to make such distinction. Technical analysis, which is widely used in day trading, is a type of scientific analysis which utilizes past price movements to predict future price movements and can be used in shorter time periods, such as daily charts, hourly charts, and even 15-minute charts (Nazário et al., 2017). Therefore, day trading is also different from gambling.

Delfabbro et al. (2021) and Mills and Nower (2019) carried out studies on regular gamblers and found that gambling behavior is associated with cryptocurrency trading. However, it may not be sufficient to address cryptocurrency use only as a form of gambling because this presents a very narrow view. Cryptocurrencies are traded online. Spending long hours on the Internet and lack of control over Internet use are generally defined as Internet addiction. In other words, spending excessive time on the Internet can be described as the most important symptom of Internet addiction. It should be noted that the cryptocurrency world also includes tokens of play-to-earn projects (Vidal-Tomás, 2022). Oksanen et al. (2022) found strong associations between cryptomarket trading and excessive gaming and between cryptomarket trading and Internet use.

The 'Components Model of Addiction': To define an activity as an addiction, the behavior of a person subjected to addiction should have six core components (Griffiths, 2005; Andreassen et al., 2012). Griffiths (2005) developed the 'Components Model of Addiction'. All addictions consist of six distinct common components according to this model: salience (the activity becomes the single most important activity in the person's life and dominates their thinking, feelings, and behavior), mood modification (engaging in the behavior to alleviate or reduce negative moods), tolerance (the process whereby increasing amounts of the activity are required to achieve the former mood modifying effects), withdrawal (unpleasant feeling states and/or physical effects that occur when the behavior is suddenly reduced or banned), conflict (delaying or ignoring social life, entertainment, work, education, home and/or other activities, and needs of self and others because of the behavior), and relapse (trying without success to reduce or control the behavior). These six components were present in scale development studies in the literature on behavioral addictions, such as gaming addiction (Lemmens et al., 2009), Facebook addiction (Andreassen et al., 2012), and Internet gaming disorder (Pontes et al., 2014).

The present study

Considering its psychological effects on people, cryptocurrency addiction should be urgently addressed by professionals as a behavioral addiction within the public mental health context (Griffiths, 2018; Mills and Nower, 2019; Milliyet, 2021). News about people who take loans from banks to buy cryptocurrency, sell their cars and houses, and lose all the money they have from these sales; people who think to get divorced, commit suicide, and develop mental health problems due to their losses in cryptocurrency markets; and people who are swindled are frequently seen in the media (Milliyet, 2021). As cryptocurrency addiction is considered both a form of gambling addiction and a form of Internet addiction and the use of cryptocurrency has been increasing rapidly, a psychometrically sound tool is needed to evaluate any possible addiction. However, only one measurement tool for cryptocurrencies that measures problematic cryptocurrency trading has been found in the literature (Mentes et al., 2021). However, this scale is only a two-factor scale (factor 1: withdrawal and tolerance, factor 2: money seeking behavior and denial), and these factors do not reflect the components of addiction well.

Therefore, this study intends to develop a new 'cryptocurrency addiction scale'. However, addressing the problem only in terms of trading can limit our understanding of the issue. Similar to Facebook addiction (Andreassen et al., 2012), the time spent following cryptocurrencies should also be included in the scope. Even if a person does not trade frequently (such as long-term investors), they can find themselves constantly following cryptocurrency markets involuntarily. Therefore, the problem is described as both trading in cryptocurrency markets and following cryptocurrency markets and instant price actions and this study aimed to develop a scale to measure cryptocurrency addiction based on Griffiths' (2005) 'Components Model of Addiction'.

RQ1. Is the Cryptocurrency Addiction Scale valid and reliable measurement tool?

RQ2. Does 'Components Model of Addiction' explain cryptocurrency addiction?

RQ3. Is there any correlation between cryptocurrency addiction, loneliness, sleepiness, and problematic Internet use?

Cryptocurrency use in Turkey and in the world

When we look at the situation in Turkey, a study conducted with the cooperation of the World Economic Forum and a company named Statista revealed the situation of cryptocurrency use in Turkey. According to that study (World Economic Forum, 2020),

Turkey comes first in Europe and fourth worldwide among the countries with the highest cryptocurrency use (the percentage of participants who report that they use or own cryptocurrency is 16% in Turkey).

In this study, Nigeria comes first, Vietnam second, the Philippines third, and Turkey fourth. Peru, Switzerland, China, the USA, Germany, and Japan followed Turkey, respectively. In contrast, some studies and news claim that the percentage of people engaged in cryptocurrency trading in Turkey is low or not as high as assumed (Tr.Euronews, 2020; Paribu and Akademetre, 2020).

According to the news on Tr.Euronews (2020), the results of the 'Cryptocurrency Awareness and Perception Survey' (Paribu and Akademetre, 2020) done by Akademetre Research Company on behalf of Paribu (a digital asset transaction platform) showed that the percentage of the population that trades cryptocurrencies in Turkey is only 0.7%.

Moreover, according to the news on Tr.Euronews (2020), ICO Analytics, which lists the countries where cryptocurrencies including most notably Bitcoin are exchanged, found that 14% of the global traffic comes from the USA. In addition, according to the results of Cointelegraph announced on 8th of May, South Korea followed the USA by 10% and Russia by 6.9%, and Turkey ranked 14th, accounting for 2.14% of the traffic (Tr.Euronews, 2020).

Although the prevalence of cryptocurrencies in Turkey is under discussion, it should be considered a behavioral addiction and addressed urgently by professionals as a public mental health problem.

Methods

Study design: This study used a descriptive, cross-sectional, and methodological design to develop a 'cryptocurrency addiction scale' and test the psychometric properties of this scale.

Setting and participants: The present study was conducted in Turkey. The inclusion criteria of the study were as follows: making cryptocurrency transactions (buy-sell) within the last six months; or following cryptocurrency markets via smartphones, computers, or television channels within the last six months; and being between 18 and 65 years of age. Data were gathered online between June 2021 and January 2022. Data were collected at two separate stages. The first stage of data collection was exploratory factor analysis (EFA). There were 279 participants who completed the data collection form. 77.4% of the participants were male ($n = 216$) and 22.6% were female ($n = 63$), and the mean age was 35.14 ± 8.79 years (ranging from 19 to 61 years). 29.4% of the participants ($n = 82$) had been following cryptocurrency markets for 0-6 months, 36.9% ($n = 103$) exchanged cryptocurrencies in the medium term (months), and 41.6% of the participants reported their economic status ($n = 116$) as 'income is equal to expenditure'. Participants spent an average of 13 ± 17.61 hours (median

= 7) weekly following cryptocurrency markets. The number of participants was sufficient ($n \geq 200$) to perform a factor analysis (Myers et al., 2011). The second stage of data collection was confirmatory factor analysis (CFA). Criterion-related validity, internal consistency reliability, and test-retest reliability were also evaluated at this stage. After the EFA stage of the study was completed, CFA, criterion-related validity, and internal consistency reliability were investigated with 289 participants (76.5% male, 23.5% female) who were not included in the previous stage. Additionally, at this stage, participants were asked to enter nicknames in the online questionnaire for test-retest reliability and asked to fill out the Cryptocurrency Addiction Scale (CAS) again two weeks later. Only 38 out of 289 participants completed the scale for the second time, and test-retest reliability analysis was performed for 38 participants.

The development process of scale items: The authors investigated scale development studies in the literature on behavioral addictions, such as game addiction, Facebook addiction, and Internet gaming disorder, and found that addictive behaviors had six core components (Griffiths, 2005; Lemmens et al., 2009; Andreassen et al., 2012; Pontes et al., 2014). Based on this information, the researchers created a question pool consisting of 36 questions about these six core components (salience, mood modification, tolerance, withdrawal, conflict, and relapse) to measure cryptocurrency addiction. The scale items were designed to cover both trading in cryptocurrency markets and following cryptocurrency markets and instant price actions. An expert's opinion was sought for the draft form that consisted of 36 items. The scale was a 5-point Likert scale ranging from 1 (almost never) to 5 (almost always). Reverse coding was not used for any of the items on the scale. Higher scores on the scale indicated higher cryptocurrency addiction.

Instruments: Research data were collected using an online self-administered form including the Personal Information Form (PIF), the Generalized Problematic Internet Use Scale 2 (GPIUS-2), De Jong Gierveld Loneliness Scale (DJGLS), and Epworth Sleepiness Scale (ESS). The PIF consists of questions about gender, age, the number of hours a week devoted to following cryptocurrency markets, how long the cryptocurrency markets have been followed, mostly on which term cryptocurrencies are invested (such as long- and short-term), and evaluation of the participants' economic status.

The GPIUS-2 was developed by Caplan (2010) and adapted to Turkish by Canogullari-Ayazseven and Cenkseven-Onder (2019). It consisted of 15 items under four factors: Preference for Online Social Interaction, Mood Regulation, Deficient Self-Regulation (including compulsive Internet use and cognitive preoccupation sub-dimensions), and Negative Outcomes. While the original version of the scale was an 8-point Likert scale, the Turkish adaptation of the scale was a 5-point Likert scale ranging from 1 (absolutely disagree) to 5 (absolutely agree). Higher scores on the scale indicated higher problematic Internet use. Cronbach's alpha reliability coefficient of the scale was 0.91 in Caplan's (2010) study and 0.85 in Canogullari-Ayazseven and Cenkseven-Onder's (2019) study. In this study, Cronbach's alpha reliability coefficient of the scale was 0.90.

The DJGLS was developed by De Jong Gierveld and Van Tilburg (2010) and adapted to Turkish by Cavdar et al. (2015), and it consisted of 11 items. The scale had two dimensions: social and emotional loneliness. It was a 4-point Likert scale ranging from 1 (not at all true of me) to 4 (extremely true of me). Items in the social loneliness dimension can be reverse-scored to obtain the total score. Higher scores on the scale indicated higher levels of loneliness. Cronbach's alpha internal reliability coefficient of the scale was 0.87 in Cavdar et al.'s (2015) study. In this study, Cronbach's alpha internal reliability coefficient of the scale was 0.87.

The ESS was developed by Johns (1994) and adapted to Turkish by Izci et al. (2008). This scale was developed to evaluate daytime sleepiness among adults. In the scale with one dimension, respondents were asked to evaluate their chance of dozing in eight different daily life situations. The scores of the scale ranged from 0 (would never doze) to 3 (high chance of dozing). Higher scores indicated higher daytime sleepiness. Cronbach's alpha internal reliability

coefficient of the scale was calculated to be over 0.86 in two different groups (Izci et al., 2008). In this study, Cronbach's alpha reliability coefficient of the scale was 0.76.

Data collection, statistical methods, and data analysis: The research data were collected online between June 2021 and January 2022. The data collection form was developed in Google questionnaire format, and a questionnaire link was created. Researchers shared this link on their social media accounts. Furthermore, they shared it with the people on their smartphone contact lists (using messaging apps) and with the people on their e-mail lists. This link was shared with cryptocurrency influencers, stock market influencers on social media platforms with a high number of followers, and economy experts who regularly appear on national channels on television, and they were asked to share this link on their pages. These people shared the research data collection form on their own pages with their followers. Furthermore, since people who are not interested in cryptocurrencies might know people who are interested, everyone who received this link was asked to share it in their network. All of the items in the online questionnaire were mandatory. Therefore, there was no missing data. Two samples were used to examine the factor structure of the CAS. The first sample was used for EFA, and the second sample was used for CFA, criterion-related validity analysis, and internal reliability analysis. Principal component analysis was used in the EFA process as the extraction method with varimax rotation. Subsequently, CFA was conducted with a maximum likelihood estimator to confirm the six-factor structure derived from EFA. In CFA, models were evaluated using four indices: (1) the χ^2/df ratio, (2) root mean square error of approximation (RMSEA), (3) comparative fit index (CFI), and (4) Tucker–Lewis index (TLI). The CFA model is considered a good fit for the data when $\chi^2/df \leq 3$, RMSEA $\leq .08$ and CFI and TLI $\geq .90$ (Kline, 2015). The maximum likelihood estimator was used for all the CFA analyses. Moreover, standardized loading values, residual terms, and modification indices were examined. To test criterion-related validity, Pearson's correlation coefficients between the CAS and GPIUS-2, DJGLS, and ESS were investigated. Based on theoretical considerations and previous research, cryptocurrency addiction is expected to be positively correlated with loneliness, sleepiness, and problematic Internet use (Andreassen et al., 2012; Oksanen et al., 2022; Johnson et al., 2023). Internal consistency reliability was defined with Cronbach's α and McDonald's ω values. The test-retest reliability of the scale was assessed using Pearson's correlation coefficient between the two measurements. IBM SPSS Statistics version 23.0, Mplus software version 7.2 (Muthen & Muthen, 1998-2004), and *R* version 4.2 were used for data analysis.

Ethical considerations: This study was conducted in accordance with the principles of the Declaration of Helsinki. This study was approved by the Non-Interventional Clinical Research Ethics Committee of the Nursing Faculty of Aydin Adnan Menderes University (Protocol Number: 2021/267). The participants were informed about the purpose and scope of the study, and their informed consent was obtained online.

Results

This study was conducted to develop the Cryptocurrency Addiction Scale and test its psychometric properties, and the results are listed below.

Construct validity

Exploratory and confirmatory factor analyses were performed to investigate the factor structure of the scale. In the first step, all 36 items were included to EFA for factor solution. The preliminary analysis showed that five candidate items did not have a factor loading and cross-loading above .50. These items were discarded from the item pool, and factor analysis was repeated. EFA was conducted for the remaining 31 items. The scree plot showed that six factors were appropriate. Sampling adequacy (KMO) was calculated as 0.917, and Bartlett's test of sphericity was calculated as $\chi^2 = 5271.65$, $df = 465$, and $p < .001$. EFA resulted in the extraction of six factors (conflict, tolerance, relapse, withdrawal, mood modification, and salience), which explained 63.41% of the total variance (Table 1). The eigenvalues of these six factors were 14.14 (39.29%), 2.81

(7.79%), 1.98 (5.49%), 1.49 (4.15%), 1.28 (3.57%), and 1.13 (3.13%), respectively.

Table 1 presents the descriptive statistics, factor loadings, communalities, and corrected item-total correlations for all the items. In the second step, CFA was performed to identify whether all the factors could be placed under a broader concept. CFA was conducted for the first- and second-order models. The second-order CFA of the 31 scale items showed an inadequate model fit (χ^2= 1141.63, *df* = 428, CFI = .87, TLI = .86, RMSEA = .076), similar to the first-order CFA model (χ^2= 1092.77, *df* = 419, CFI = .88, TLI = .86, RMSEA = .075).

Therefore, a set of correlated errors needed to be corrected to improve fit. After this step, the results of CFA revealed that the first-order CFA model (χ^2= 948.156, *df* = 416, CFI = .90, TLI = .90, RMSEA = .067) and the second-order CFA model (χ^2= 995.642, *df* = 425, CFI = .90, TLI = .90, RMSEA = .068) were confirmed.

Table 2 presents the factor loadings of the second-order CFA model (Table 2, Figure 1).

Criterion-related validity Criterion-related validity was evaluated using Pearson's correlations between the CAS and GPIUS-2, DJGLS, and ESS.

The CAS scores of the participants showed a medium-to-large positive correlation with the GPIUS-2 scores and a small-to-medium positive correlation with the DJGLS and ESS scores, and all of these correlations were statistically significant (Table 3).

Internal reliability and test-retest reliability

The internal consistency of the six subscales was examined using Cronbach's alpha (α) and McDonald's omega (ω) coefficients. According to the reliability results, coefficient alphas were high, ranging from .74 (salience) to .90 (tolerance). For the total scale, Cronbach's alpha was 0.93.

Moreover, McDonald's omega estimates showed that the coefficients were high, ranging from .77 (salience) to .90 (tolerance). For the total points of the scale, McDonald's omega was 0.93. The test-retest reliability ranged from .68 (tolerance) to .93 (relapse; see Table 4).

Test-retest correlation was found to be .92 for the total score (95% confidence interval .74 - .98, $p < 0.001$).

Table 1. EFA results of the Cryptocurrency Addiction Scale (*n* = 279)

Factors	Item	M	SD	Factor loadings	Communalities	Corrected Item-Total Correlation
	Item 32	1.28	.63	.79	.68	.49
	Item 5	1.35	.72	.79	.73	.59
	Item 31	1.30	.66	.78	.66	.51
Conflict	Item 14	1.42	.84	.70	.54	.38
	Item 20	1.44	.79	.69	.74	.60
	Item 25	1.32	.75	.64	.61	.57
	Item 13	1.38	.74	.60	.60	.60

	Item 30	1.69	.89	.54	.51	.51
Tolerance	Item 11	1.95	1.12	.75	.74	.68
	Item 3	2.57	1.28	.71	.74	.70
	Item 36	2.61	1.18	.68	.69	.68
	Item 23	2.05	1.12	.68	.77	.73
	Item 34	2.57	1.18	.58	.71	.70
Relapse	Item 33	1.82	1.08	.75	.71	.60
	Item 19	2.85	1.38	.69	.57	.48
	Item 7	2.20	1.38	.68	.51	.45
	Item 8	2.09	1.20	.65	.63	.63
	Item 26	1.78	1.05	.54	.67	.67
	Item 15	1.75	.99	.51	.54	.65
Withdrawal	Item 4	1.92	1.04	.63	.69	.68
	Item 24	1.29	.65	.61	.54	.53
	Item 35	2.02	1.06	.59	.70	.71
Mood modification	Item 2	1.85	1.05	.81	.73	.48
	Item 28	1.80	1.10	.72	.73	.52
	Item 27	2.12	1.18	.71	.68	.56
	Item 22	2.33	1.25	.67	.63	.49
	Item 17	2.77	1.00	.56	.60	.50
Salience	Item 1	2.81	1.14	.66	.52	.33
	Item 21	2.80	1.09	.65	.69	.65
	Item 9	2.08	1.20	.59	.58	.52

Item 29	2.22	1.17	.53	.60	.66

Note: M = Mean, SD = standard deviation.

Table 2. Factor loadings by the second-order CFA model (*n* = 289)

Factors	Items In the last six months, how often	Second-order CFA item loadings
Conflict	32. did you argue with people around you (family, friends, etc.) because of the time you spent on cryptocurrencies?	.78
	5. did the time you spent on cryptocurrencies have a negative impact on your relationships with your family, friends, or work/school environment?	.83
	31. did you have problems with your family because of the time you spent on cryptocurrencies?	.76
	14. did people around you pressure you to stop following cryptocurrency markets?	.59
	20. did you ignore people around you (family, friends, etc.) because of the time you spent on cryptocurrencies?	.80
	25. did you lie to others about the time you spent on cryptocurrencies?	.72
	13. did you have trouble in finishing your work because of your passion with cryptocurrencies?	.71
	30. did your friends who do not engage in cryptocurrency markets get bored when they are with you because you kept talking about cryptocurrencies all the time?	.58
Tolerance	11. did you feel the need to increase the time you spent on cryptocurrency markets to maintain the emotional effects you felt when you first started?	.75
	3. did you start to spend more time on cryptocurrencies than you intended at first?	.86
	36. did you feel the urge to make increasingly more cryptocurrency transactions?	.81
	23. did you feel the need to spend more time on cryptocurrencies to get the same excitement/pleasure?	.80
	34. did you increasingly spend more time to follow cryptocurrency markets?	.81

Relapse	33. did you feel that it was very difficult for you to stop following cryptocurrencies?	.77
	19. were you unable to stop following cryptocurrencies although you had switched to cash?	.60
	7. did you think that you cannot stop following cryptocurrency markets forever?	.56
	8. , whenever you stopped engaging in cryptocurrencies, did you start again after a while?	.76
	26. were you unable to reduce the time you spent on cryptocurrencies?	.78
	15. did you have difficulty stopping yourself from making transactions in cryptocurrency markets?	.73
Withdrawal	4. did you feel stressed when there were situations in which you could not check cryptocurrency markets?	.58
	24. did you have psychological or physical problems when you kept away from cryptocurrency markets?	.90
	35. did you worry when you could not follow cryptocurrency markets for various reasons (at work, in school, or in somewhere without Internet connection)?	.91
Mood modification	2. did you engage in cryptocurrency markets to relieve your stress?	.66
	28. did you follow cryptocurrencies or make transactions to forget your personal problems?	.62
	27. did you turn to cryptocurrency markets to feel better?	.75
	22. did you turn to cryptocurrency markets for feelings of excitement and pleasure?	.67
	17. did you feel better when you engage in cryptocurrency markets?	.66
Salience	1. were you unable to stop yourself from looking at instant price actions of cryptocurrencies or checking on your cryptocurrency wallet?	.37
	21. did you spend too much time on thinking about cryptocurrencies?	.83
	9. did you prefer to look first at the cryptocurrency markets even when you have an important message from a loved one on your phone?	.68
	29. did you think about making cryptocurrency transactions all day?	.77

Note: All loadings are statistically significant (all *p*s < .001)

Table 3. Criterion-related validity results and mean scores of the scales (*n* = 289)

Scales	CAS	Bootstrap***	Min	Max	Mean	SD
Cryptocurrency addiction	*r* = 1	-	31	127	60.4	19.8
Problematic Internet use	*r* = .39*	(.27) - (.50)	15	66	35.2	11
Loneliness	*r* = .23*	(.12) - (.34)	11	40	22.3	6.6
Sleepiness	*r* = .20**	(.07) - (.33)	0	22	6.9	3.9

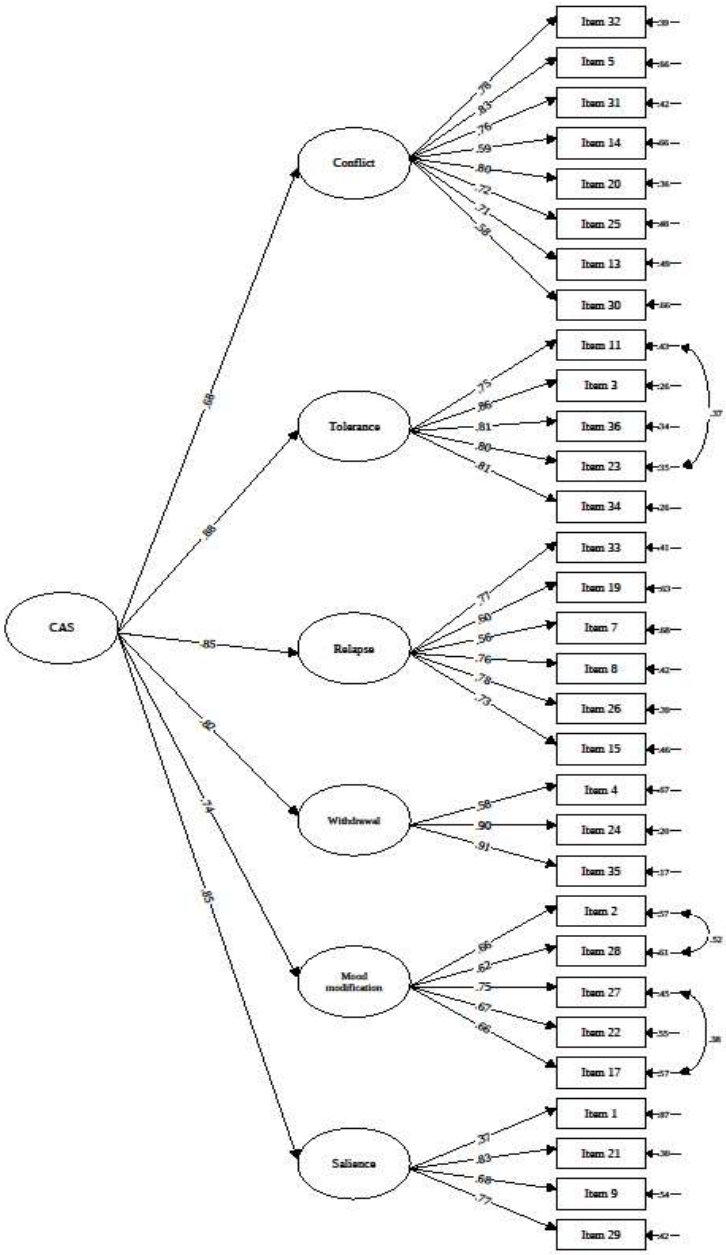
* $p < 0.001$, ** $p = 0.001$, ***Bootstrap 95% Confidence Interval Lower and Upper Values, SD = Standard deviation

Table 4. Test-retest reliability of the Cryptocurrency Addiction Scale and its subscales (*n* = 38)

	CAS	Conflict	Tolerance	Relapse	Withdrawal	Mood modification	Salience
r	.92*	.86*	.68**	.93*	.82*	.85*	.77*

* $p < 0.001$, ** $p < 0.01$

Figure 1. The figure path for the second-order CFA model



Discussion

This study introduces one of the first scales that measures cryptocurrency addiction in the literature. This study used a descriptive, cross-sectional, and methodological design to develop a scale that measures cryptocurrency addiction. In contrast to other studies in the literature (Griffiths, 2018; Mills and Nower, 2019; Delfabbro et al., 2021), cryptocurrency addiction in this study is considered a form of not only gambling addiction but also Internet addiction. This study found that the CAS met the construct validity, criterion-related validity, internal consistency reliability, and test-retest reliability criteria. This study also found a significant positive correlation between cryptocurrency addiction and sleepiness that has not been reported in previous studies.

The 'components model of addiction' of Griffiths (2005) claims that all types of addiction have some common components (salience, mood modification, tolerance, withdrawal, conflict, and relapse). These six components were present in scale development studies in the literature on behavioral addictions, such as gaming addiction (Lemmens et al., 2009), Facebook addiction (Andreassen et al., 2012), and Internet gaming disorder (Pontes et al., 2014). Similarly, in this study, based on the EFA results of the CAS, six factors were determined. The first factor consists of eight items and is labeled as 'conflict'. This refers to the interpersonal and intrapsychic conflicts of an addictive person engaging in a particular activity. The second factor consists of five items and is labeled as 'tolerance'. This refers to the need to increase the frequency of a certain activity to achieve its previous effects. The third factor consists of six items and is labeled as 'relapse'. This refers to the tendency to return to previous patterns of a particular activity after abstinence or control. The fourth factor consists of three items and is labeled as 'withdrawal'. This refers to unpleasant feelings and/or physical effects which occur when a particular activity is discontinued or suddenly reduced. The fifth factor consists of five items and is labeled as 'mood modification'. This refers to the subjective experiences reported by people as a result of their engagement in a particular activity to improve their moods. The sixth factor consists of four items and is labeled as 'salience'. This refers to a situation in which a particular activity becomes the most important activity in a person's life and dominates their thinking, feelings, and behavior. The results of our exploratory and confirmatory factor analyses are similar to those found in the literature (Griffiths, 2005; Lemmens et al., 2009; Andreassen et al., 2012; Pontes et al., 2014).

Criterion-related validity was tested using Pearson's correlations between the CAS and several self-report measures. As expected, cryptocurrency addiction levels showed a positive correlation with problematic Internet use, loneliness, and sleepiness levels. These findings are similar to those reported in the literature (Delfabbro et al., 2021; Oksanen et al., 2022; Johnson et al., 2023). In this study, cryptocurrency addiction levels of the participants showed a positive correlation with problematic Internet use. Similarly, in their study on Finnish participants, Oksanen et al. (2022) found that cryptocurrency market traders reported higher levels of excessive gambling, excessive gaming, excessive Internet use, and excessive alcohol intake compared to non-investors. A situation in which highly volatile assets are traded and dubious but high profits are hoped is similar to the basics of gambling (Mills and Nower, 2019; Delfabbro et al., 2021). However, cryptocurrencies are traded online. Even if a person does not trade frequently (such as long-term investors), they can find themselves spending long hours on the Internet constantly following cryptocurrency markets, instant price actions, and their cryptocurrency wallets. This can explain the association between cryptocurrency addiction and Internet use. Tokens of play-to-earn projects (Vidal-Tomás, 2022) can also increase the time spent on the Internet.

In this study, cryptocurrency addiction levels of the participants showed a positive correlation with their loneliness levels. This finding is consistent with previous findings in the literature (Oksanen et al., 2022; Johnson et al., 2023). Similarly, in their study on Finnish participants, Oksanen et al. (2022) found that cryptocurrency market traders reported higher levels of perceived loneliness

than non-investors. However, in their study of two different groups of adolescents to develop a gaming addiction scale for adolescents, Lemmens et al. (2009) found a significant correlation between the time spent on gaming and loneliness in one group but did not find any significant correlation in the other group. On the one hand, people with a particular behavioral addiction may be isolating themselves from the people they have in their daily lives before they acquire this addictive behavior. On the other hand, they may be getting together and socializing with other people who have the same behavioral addiction, and this may help to reduce their loneliness perceptions. Therefore, when evaluating loneliness in someone with behavioral addiction, the people with whom this person has recently socialized should also be considered.

We also found statistically significant positive correlation between cryptocurrency addiction and sleepiness that has not been reported in previous studies. Johnson et al. (2023) emphasized this gap. In their study on college students to develop a Facebook addiction scale, Andreassen et al. (2012) found that Facebook addiction was correlated with late bedtimes and late rising times on both weekdays and weekends. The findings of this study are supported by the literature. Furthermore, the large effect positive correlation between the CAS test and retest scores of the participants demonstrates that the scale is time invariant. The findings showed that criterion-related validity and test-retest reliability were satisfactory. Additionally, internal consistency was satisfactory.

Limitations: This is a cross-sectional study. The data collected are valid only for the time period when the study was conducted and can change depending on the time. Additionally, the main data of the study were obtained through self-report. Therefore, the data obtained from the scales can be different from the data observed by the researchers.

When the concepts measured by a scale and the scale items are understood and conceptualized by people with different language backgrounds, this means that the scale is measurement invariant. Another limitation of this study is that since it was conducted on a group of only Turkish participants, measurement invariance analysis could not be performed.

Conclusions: The results of this study showed that the Turkish version of the CAS is a valid and reliable measurement tool. This study is important as it introduces to the international literature one of the first scales that measure cryptocurrency addiction and uses the 'Components Model of Addiction' as a basis for the development process of the scale. Since cryptocurrency addiction is an important public health problem, accurate measurement of individuals' addiction levels is expected to provide baseline data to better understand the concept of cryptocurrency addiction. Validity and reliability studies of the CAS in other languages and assessment of the scale for measurement invariance analysis will allow us to better understand the psychometric properties of the scale. Further studies using the CAS to investigate the relationship between the concept and different variables are recommended.

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