



BSc in Psychology
Department of Psychology

The Relationship Between Exercise
Dependence and Energy Drink Consumption
The Mediating Effect of Beliefs About Caffeine
Enhancing Athletic Performance

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Foreword

Submitted in partial fulfilment of the requirements of the BSc Psychology degree, Reykjavik University, this thesis is presented in the style of an article for submission to a peer-reviewed journal.

This thesis was completed in the Spring of 2022 and may therefore have been significantly impacted by the COVID-19 pandemic. The thesis and its findings should be viewed in light of that.

Abstract

Exercise has been strongly related to many positive effects such as self-perceived quality of life and improvement of psychological, physiological and immunological functions. Despite the positive effects of exercise to most people, it can become problematic to some, resulting in exercise dependence. For the past decades, the consumption of energy drinks has been on the rise, with accompanied health risks. The relationship between energy drink consumption and exercise dependence was studied, looking into beliefs about caffeine enhancing athletic performance as a mediator factor. Results showed a significant positive relationship between exercise dependence and energy drink consumption and between energy drink consumption and believing caffeine enhances athletic performance. The results further showed that the relationship between energy drink consumption and exercise dependence was partially mediated through caffeine beliefs. These findings indicate that targeting society's beliefs about athletic enhancement through caffeine could help decrease the consumption of energy drinks.

Keywords: Exercise dependence, energy drinks, athletic enhancement, beliefs

Útdráttur

Líkamsrækt hefur lengi verið tengd við jákvæð áhrif eins og upplifun á auknum lífsgæðum, bættri sálfræðilegri og lífeðlisfræðilegri starfsemi ásamt bættu ónæmiskerfi. Þrátt fyrir jákvæð áhrif líkamsræktar, getur líkamsrækt í einhverjum tilfellum orðið að líkamsræktarvíkn. Síðastliðna áratugi hefur neysla orkudrykkja farið hækkandi, ásamt meðfylgjandi heilsuvanda. Í þessari rannsókn var samband líkamsræktarvíknar og orkudrykkjaneyslu skoðað ásamt trú á því að koffín bæti frammistöðu í líkamsrækt. Niðurstöður sýndu fram á marktækt samband milli líkamsræktarvíkn og aukinni orkudrykkjaneyslu ásamt marktæku sambandi milli orkudrykkjaneyslu og þess að trúa að koffín bæti frammistöðu í líkamsrækt. Sambandið milli orkudrykkjaneyslu og líkamsræktarvíknar var að hluta til skýrt útfrá viðhorfum gagnvart frammistöðu bætandi áhrifum koffíns. Þessar niðurstöður benda til þess að aðgerðir sem vinna að leiðum við að hafa áhrif á viðhorf fólks gætu hjálpað til að draga úr orkudrykkjaneyslu, ásamt öðrum inngrípum.

Lykilorð: Líkamsræktarvíkn, orkudrykkjaneysla, frammistaða, viðhorf

**The Relationship Between Exercise Dependence and Energy Drink
Consumption: The Mediating Effect of Beliefs About Caffeine Enhancing Athletic
Performance**

Exercise has been strongly related to many positive effects, such as self-perceived quality of life (Laforge et al., 1999; Nguyen et al., 2020) and improvement of psychological, physiological, and immunological functions (Mikkelsen et al., 2017). Despite the positive effects of exercise to most people, it can become problematic to some, resulting in exercise dependence (Deck et al., 2021).

Exercise Dependence

Exercise dependence, also known as exercise addiction, is one of several behavioral addictions which has not yet been qualified for the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5). This is due to lack of clarity on co-occurring disorders, along with the effects and definition of exercise dependence (Colledge et al., 2020). Instead, other measurements have been made and used when measuring symptoms of exercise dependence. Studies have shown that a small percentage of the world's population shows symptoms of exercise dependence (Lichtenstein & Jensen, 2016). Studies using the Exercise Addiction Inventory (EAI) found that 5% of the CrossFit population shows symptoms of exercise dependence (Lichtenstein & Jensen, 2016), 7-10% of university athletes and 17% among ultra-marathon runners (Szabo et al., 2013). The causality of exercise dependence is thus not clear. However, multiple studies have shown that those who are at risk for exercise dependence score higher on at least one additional mental disorder, most commonly: symptoms of eating disorders (Levit et al., 2018), and anxiety (Mayolas-Pi et al., 2016), compared to those at a lower risk of exercise dependence. There has also been found a correlation between exercise dependence and depression (Li et al., 2015) and the use of performance-enhancing drugs (Lichtenstein, 2020). Surprisingly, given that consumption

of energy drinks has increased significantly (Gunja & Brown, 2012), few studies have looked at how exercise dependence relates to energy drink consumption or caffeine consumption in general.

Caffeine and Energy Drinks

A study using a multi-round online questionnaire examined the use of energy drinks, dietary supplements, and prescription medications among U.S. college students to enhance athletic performance (Hoyte et al., 2013). The results showed that 80% of the student-athletes used energy drinks, and 64% used dietary supplements to enhance athletic performance. Studies support that caffeine consumption can enhance athletic performance during a workout to a certain extent (Clarke et al., 2018; Wiles et al., 2006). However, it is worth noting that caffeine can have adverse effects later, such as reduced sleep quantity and quality (Ramos-Campo et al., 2019). Low sleep quality, in turn, can impair recovery following exercise (Myllymäki et al., 2011) and simulate symptoms of overtraining (Fullagar et al., 2015). So even though caffeine consumption before a workout can enhance performance during the following workout, it could mean that a workout the following day could face the negative side effects. Relating this to exercise dependence, a previous study (Mayolas-Pi et al., 2016) revealed a lower sleep quality among amateur endurance cyclists at risk for exercise dependence in comparison to those at a lower risk. The findings also revealed that those at risk for exercise dependence had a lower mental quality of life and higher anxiety levels.

Consuming energy drinks is linked to adverse health effects, such as a significant reduction in enamel hardness, negatively impacting oral health (Sapna et al., 2020). Other implications regarding energy drink consumption include liver damage, kidney failure, seizures, and heart failure (Seifert et al., 2011). The number of hospitalizations related to caffeine toxicity and overdose associated with energy drink consumption has been on the rise

(Gunja & Brown, 2012). There are even some cases of sudden death due to caffeine overdose (Eichner, 2014).

Beliefs about Caffeine Enhancing Performance

With little knowledge about how caffeine is for enhancing athletic performance, it is interesting how much energy drinks are marketed toward athletic people on social media. An Icelandic study (Jenný Harðardóttir, 2019), examining the image of energy drinks on Instagram showed that energy drinks were promoted as a healthy drink, enhancing energy. The energy drinks were often associated with physical exercise and often promoted through collaboration with athletes or other influencers. One of those drinks which has been popular in Iceland is Nocco, an energy drink containing branched chain amino acids and vitamins. In 2019, 50% of Nocco's Instagram posts were related to exercise. Ripped, another energy drink brand, associated their product with exercise by using the words energy, fat burn and recovery.

Even though caffeine is the most widely used psychoactive drug in the world, little research has been done on its relationship with expectancies. Expectancies for drug effects are a predictor of the start of drug use, the continuance of drug use, relapse and quitting (Huntley & Juliano, 2012). Higher frequency and quantity of caffeine have been associated with greater expectancies for energy and mood enhancement as well as physical performance enhancement. Another study (McIlvain et al., 2012) revealed that beliefs about caffeine increasing alertness were a strong predictor of high caffeine consumption.

Purpose of the Present Study

The main purpose of the present study is to investigate the relationship between exercise dependence, energy drink consumption and beliefs about caffeine enhancing athletic performance. According to the researcher's knowledge, the relationship between exercise dependence and energy drink consumption has not been examined before. This will also be

one of the first studies examining exercise dependence among an Icelandic sample. Since previous studies have revealed adverse effects of exercise dependence on mental health (Laforge et al., 1999; Nguyen et al., 2020; Mikkelsen et al., 2017) and adverse effects of energy drink consumption on physical health (Eichner, 2014; Gunja & Brown, 2012; Sapna et al., 2020; Seifert et al., 2011) it is important to gain a better understanding of modifiable factors that potentially affect the relationship between exercise dependence and energy drink consumption. The first hypothesis of this study is that there will be a positive relationship between exercise dependence and the consumption of energy drinks. The second hypothesis is that there will be a positive association between exercise dependence and beliefs about athletic enhancing effects of caffeine. The third hypothesis is that beliefs towards athletic enhancement through caffeine will be positively associated with energy drink consumption. The fourth hypothesis regards beliefs will mediate the relationship between exercise dependence and energy drink consumption about caffeine enhancing athletic performance.

Method

Participants

A total of 339 individuals answered the survey, 206 female (60.9%) and 132 male (39.1%). Participants' age ranged from 18 to 65 years old. Most participants were 22-25 years old (31.7%). Participants were students from Reykjavik University. The inclusion criteria were that participants understood Icelandic since the questionnaire was in Icelandic. The teaching department of the University of Reykjavík sent out the questionnaires to the school's students through email, using voluntary response sampling. Anyone who got the email and could read Icelandic could participate.

Measures

The Exercise Dependence Scale-21 (EDS-21)

In the present study, the Icelandic version of the Exercise Dependence Scale-21 (EDS-21) was used to examine total scores and symptoms of exercise dependence (see appendix A1) (Hausenblas & Downs, 2017). The questions from EDS-21 were divided into seven characteristics of exercise dependence symptoms: tolerance, withdrawal, intention effect, lack of control, spending a great time to obtain exercise, reduction in other activities, and continuance despite physical or psychological problems. To meet the criteria for exercise dependence, using the EDS-21, there must be a clinically significant impairment or distress that manifests in three or more of these symptoms. The reason for choosing this measurement was that it was the only measurement measuring exercise dependence that had been translated to Icelandic. The psychometric properties of the original one are considered acceptable (Hausenblas and Downs, 2002); In the English version, a seven-day test-retest reliability was found $r = 0.95$. Psychometric properties of EDS-21 were calculated in an Icelandic study that looked at the relationship between exercise, obsessive-compulsive disorder (OCD), eating disorders and exercise dependence (Fjóla Dís Markúsdóttir and Malena Íridard. Þórisdóttir, 2015). Based on Cronbach's alpha, the psychometric properties for the Icelandic EDS-21 was $\alpha = 0.958$, which is considered acceptable. In the present study, however, the psychometric properties for the Icelandic version of EDS-21 were $\alpha = .917$, which is also considered acceptable. According to EDS-21 scale scoring, three outcomes were possible: being at risk for exercise dependence, non-dependent symptomatic and non-dependent asymptomatic (Hausenblas & Downs, 2002). Out of seven sub-categories, scoring three or more would classify into the dependent category. More specifically, scoring five or six out of seven would classify as exercise dependent; scoring three or four is classified as symptomatic or at-risk for exercise dependence. Finally, individuals scoring one to two would classify as asymptomatic. Participants were asked to answer questions about their current exercise beliefs and behaviors for the past three months. However, it is worth noting

that the covid pandemic might have influenced people's exercise habits. The answers were on a Likert scale, with "1" representing "never" and "6" representing "always". Examples of the questions from EDS-21 are "I exercise to avoid feeling anxious", "I am unable to reduce how intense I exercise", and "I choose to exercise so that I can get out of spending time with family/friends".

Caffeine Consumption

Participants were asked about how much-caffeinated drinks (coffee, tea, or other caffeinated beverages) they drank per week; "daily", "at least once a week", "fewer times than once a week", "have drunk caffeinated drinks but quit", "have never drunk caffeinated drinks". Secondly, participants who indicated that they drank caffeine were asked how many caffeinated drinks they had consumed on average per day for the last month. Since energy drinks (example: Nocco, Red Bull, Monster and Collab) contain different amounts of caffeine, two questions were asked: energy drinks containing 105mg of caffeine and another 160-180mg of caffeine. Participants were asked about their caffeinated pre-workout consumption (example: Amino Energy, Ripper, C4). Since pre-workout can contain very different amounts of caffeine per serving size, the question stated, "I do not drink pre-workout", "50mg caffeine", "100mg caffeine", "150mg caffeine", "200mg caffeine", "250mg caffeine", "300mg caffeine" and "400mg or more". At last, participants were asked about the consumption of caffeine pills (example, pure performance caffeine – 200mg caffeine per pill) with the options "I do not consume caffeine pills", "one pill", "two pills", "three pills", "four or more". Thirdly, participants were asked when their last dose is usually in the day: "before noon (12 pm)", "before 2 pm", "before 4 pm", "before 6 pm", "after 6 pm", and "not applicable" for those who do not consume caffeine regularly.

Beliefs About Caffeine Enhancing Athletic Performance

Participants were asked if they had engaged in physical exercise in the past three months. If they answered yes, they indicated how much they agreed or disagreed with the following statement: "caffeine enhances my athletic performance". Answering options were on a Likert scale; "strongly agree", "somewhat agree", "neither agree nor disagree", "somewhat disagree", and "strongly disagree".

Procedure

The survey was made using REDcap. The teaching department of the University of Reykjavík sent out a questionnaire to the school's students through email. The possibility to answer the questionnaire was open for a limited amount of time. Participants were also told that their answers were important and that it would be appreciated if they responded as honestly as possible. Next, participants were informed that by participating in the study, they could participate in a jackpot where two participants could win a gift card of 50.000 Icelandic kroners, and three participants could win 25.000 Icelandic kroners. Ten participants could win 10.000 Icelandic kroners. In addition, participants were informed that the study was carried out by Reykjavik University's psychology department in collaboration with R.U.'s teaching department. The email stated that Birna Baldursdóttir, lecturer at R.U.'s psychology faculty, was responsible for the research and that complete confidentiality would be maintained in the storage and handling of the data. Then, participants were informed that The Science Ethics Committee and the Data Protection Authority had given permission for the study. Before answering the questionnaire, participants were asked to read a fact sheet about the study. At last, there was a link to the study where participants could answer the survey on the internet. When opening the online survey, participants were informed that answering the questionnaire was equivalent to agreeing to participate. Before answering the questionnaire, participants were informed that there were no risks considered to be involved in participating in the study, as most of the questions had been tested and verified in previous studies.

Nevertheless, if answering the questionnaire caused discomfort, participants could seek help from psychologist Valgerður Kristín Eiríksdóttir for one session free of charge. Participants were informed that they had no obligation to participate in the study and were always free to withdraw from the study. It was also stated that participants had the right to have the data collected in the study deleted and not used if wished. After the time frame of participating in the study was up, researchers gathered the information in Excel and transferred it to SPSS, where data was calculated and processed.

Research Design and Data Analyses

The study was cross-sectional and used an internet survey through email. The study examined the correlation between exercise dependence, consumption of energy drinks and beliefs about caffeine enhancing athletic performance. The independent variable was exercise dependence. The study had two dependent variables: energy drink consumption and beliefs about caffeine enhancing athletic performance as a mediating variable.

All data analyses were conducted in the Statistical Package for the Social Sciences, version 27 (SPSS). ANOVA was used for the calculation of exercise dependence.

Participants could not be classified into, exercise dependent, at-risk for exercise dependence or asymptomatic groups as none of the participants scored high enough on the exercise scale to be considered dependent and only two could be considered at-risk for dependence.

Therefore, the total score on the exercise dependence scale was used as a continuous variable in all data analyses. Descriptive statistics and chi-square tests were used for other measurements along with process matrix and pearson correlation to examine the mediation effect of caffeine beliefs. For Pearson correlation, the correlation was interpreted by Dancy and Reidy's guidelines (2007); 0.1 up to 0.3 standing for a weak correlation, 0.4 to 0.6 for a moderate correlation, 0.7 to 0.9 for a strong correlation and 1.0 for a perfect correlation. Two questions were asked about energy drink consumption. However, 16.5% only answered one

of the questions about energy drink consumption, leaving the other blank instead of answering that they did not consume 160-180 or 105mg caffeinated energy drinks on an average day. In those cases, their replies were excluded and filed as missing. In terms of statistical processing, agreeing that caffeine enhances athletic performance was originally number one, and disagreeing was numbered five. Strongly agreeing and somewhat agreeing were computed into one answering option, agree. Somewhat disagree and strongly disagree were also computed together into one answering option during statistical processing, disagree. Agree, neutral and disagree was then recoded, so a higher number would mean having more positive beliefs about caffeine.

Results

Out of 324 participants who indicated whether they had engaged in psychical exercise in the past three months, 211 (65%) had engaged in physical exercise while 113 (35%) had not. Based on total exercise dependence scores, seven characteristics of exercise dependence were analyzed with descriptive statistics. Table 1 shows the highest scores on withdrawal ($M = 5.5$, $SD = 1.8$) and tolerance ($M = 5.3$, $SD = 1.5$) compared to other symptoms of exercise dependence.

Table 1

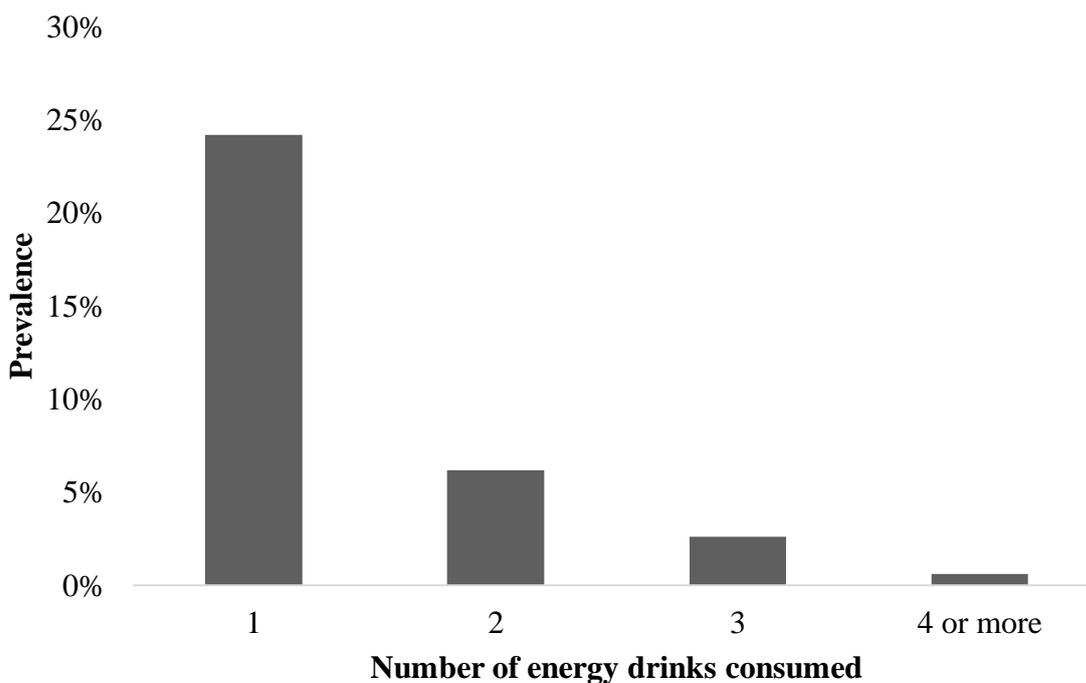
Means and Standard Deviation of Characteristics of Exercise Dependence

	<i>M</i>	<i>SD</i>
Withdrawal	5.5	1.8
Continuance	2.8	1.1
Tolerance	5.3	1.5
Lack of control	4.4	1.5
Reduction in other activities	4.1	1.2
Time	4.6	1.6
Intention effect	4.5	1.6

Regarding caffeine consumption, 67.6% drank caffeinated drinks daily. Concerning energy drink consumption, 60.9% drank energy drinks daily while 39.1% did not. Figure 1 shows that among those who consumed energy drinks daily, 24.2% consumed one energy drink per day and 9.4% more than one energy drink per day.

Figure 1

Prevalence of number of energy drinks consumed daily

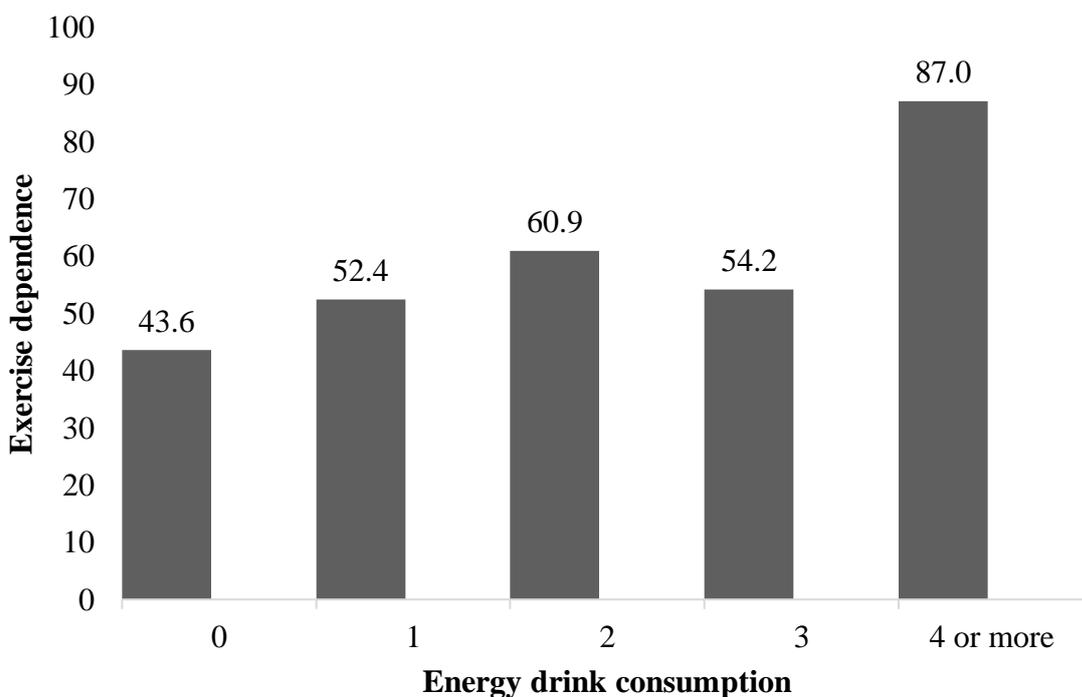


Regarding pre-workout, 56.7% did not consume caffeinated pre-workout on a daily basis. Those who consumed caffeinated pre-workout consumed about 50mg (2.4%) or 100mg (3.9%) of caffeine through pre-workout. Only one participant consumed caffeine tablets, including approximately 200mg of caffeine. Only 9% consumed their last portion of caffeine before noon regarding the time of consumption. About 15% consumed their last dose before 2 pm, but 33% consumed their last amount of caffeine after 2 pm.

Examining the relationship between exercise dependence and energy drink consumption, one-way ANOVA was performed. The results revealed a significant relationship between higher scores on the exercise dependent scale being associated with higher energy drink consumption, $F(4, 142) = 6.59, p < .001$. Results from post hoc analysis using Bonferroni revealed a significant difference between energy drink consumption and exercise dependence scores among those who did not consume energy drinks per day ($p = .048$), who consumed one energy drink a day ($p = .01$) and four or more energy drinks a day ($p = .003$), but not three a day ($p = .35$). Figure 2 shows that higher energy drink consumption was associated with higher scores on the exercise dependence scale.

Figure 2

Average Energy Drink Consumption and the Total Score (Mean) For Exercise Dependence



Note. Energy drink consumption increases as the mean score of exercise dependence increases showing a positive linear relationship.

Table 2 shows the results of the Pearson correlation, assessing the relationship between energy drink consumption and the seven characteristics of exercise dependence; withdrawal, continuance, tolerance, reduction in other activities, lack of control, time and intention effect. A significant positive correlation ($p < .001$) was found between energy drink consumption and continuance, tolerance, reduction in other activities, and time and intention effect. However, an insignificant correlation was found between energy drink consumption and symptoms of withdrawal ($p = .202$) and lack of control ($p = .063$) within exercise dependence. The strongest correlation was found between energy drink consumption and intention effect, $r = .348$, meaning exercising for longer or more intense than intended had the strongest association with higher energy drink consumption compared to other characteristics of exercise dependence.

Table 2

Correlation Between Energy Drink Consumption and Characteristics of Exercise

Dependence

Variable	Energy drink consumption
Withdrawal	.104
Continuance	.324**
Tolerance	.283**
Lack of control	.151
Reduction in other activities	.261**
Time	.328**
Intention effect	.348**

Note. The exercise dependence sample ($n = 147$)

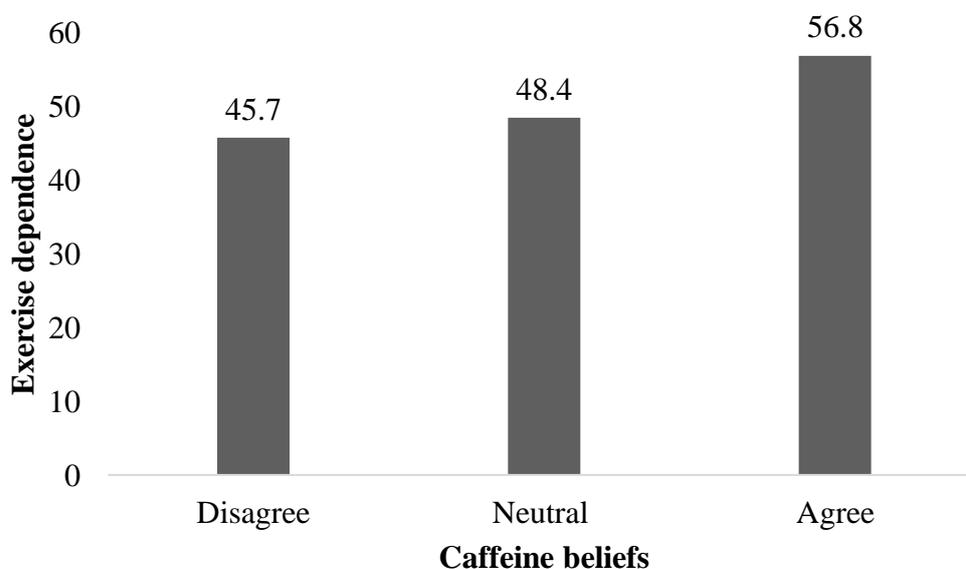
** $p < .01$.

One-way ANOVA was used to examine the hypothesis that higher scores on the exercise dependence scale were associated with believing caffeine enhances athletic

performance. The results showed that this relationship was statistically significant, $F(2, 167) = 6.77, p < .001$. Figure 3 shows the mean score of exercise dependence among those who disagree, have neutral beliefs, and agree that caffeine enhances athletic performance. The highest exercise dependence score was found among those with positive beliefs about caffeine. A post hoc comparison using Bonferroni showed a significant difference in exercise dependence among those who disagreed versus agreed with caffeine enhancing athletic performance ($p = .01$). There was also a significant difference in exercise dependence scores among those with neutral beliefs versus positive beliefs about caffeine enhancing athletic performance ($p = .02$). However, an insignificant relationship was found between the mean score of exercise dependence among those who disagreed versus had neutral beliefs about caffeine enhancing athletic performance ($p = 1$).

Figure 3

Mean Score of Exercise Dependence and Beliefs About Caffeine Enhancing Athletic Performance



A Chi-square analysis confirmed that the hypothesis that stronger caffeine beliefs were associated with more energy drink consumption was supported, $X^2(6, N = 152) = 24.3$,

$p < .001$. Table 3 shows the relationship between beliefs about caffeine enhancing athletic performance and energy drink consumption. The figure shows that among those who drink one energy drink a day, the majority have neutral (68%) or negative (66.7%) beliefs about caffeine enhancing athletic performance. For those drinking more than one can a day, the majority had positive beliefs about caffeine enhancing athletic performance. Those who drank four or more energy drinks a day had positive beliefs about caffeine enhancing athletic performance.

Table 3

The Relationship Between Energy Drink Consumption and Beliefs About Caffeine Enhancing Athletic Performance

Caffeine Beliefs	Disagree		Neutral		Agree	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Energy drink consumption						
1 can	10	66.7	17	68	28	25
2 cans	5	33.3	6	24	59	57.7
3 cans	0	0	1	4	12	10.7
4 or more	0	0	1	4	13	11.6

A Pearson correlation coefficient was computed to examine the strength of the relationship between caffeine beliefs, energy drink consumption and exercise dependence. Table 4 shows that the correlation between energy drink consumption and caffeine beliefs was .31, indicating that the higher the consumption of energy drinks, the more people agreed with caffeine enhancing athletic performance. Secondly, the correlation between energy drink consumption and exercise dependence was a little stronger or .35, indicating that the higher

scores on the exercise dependence scale, the higher the energy drink consumption was on average. Thirdly, the weakest correlation was found between exercise dependence and caffeine beliefs with a correlation of .25, indicating that higher scores on the exercise dependence scale were somewhat associated with more positive beliefs about caffeine enhancing athletic performance. A weak correlation was found between all variables, except for the relationship between energy drink consumption and exercise dependence, gravitating towards a moderate correlation.

Table 4*Correlation between Energy Drink Consumption, Exercise Dependence and Caffeine Beliefs*

Variable	1	2	3
1. Exercise dependence	–	–	.25**
2. Energy drink consumption	.35**	–	–
3. Caffeine beliefs	–	.31**	–

Note. The results for the exercise dependence sample ($n = 147$), the energy drink sample ($n = 152$), and caffeine beliefs ($n = 206$) are shown above the diagonal.

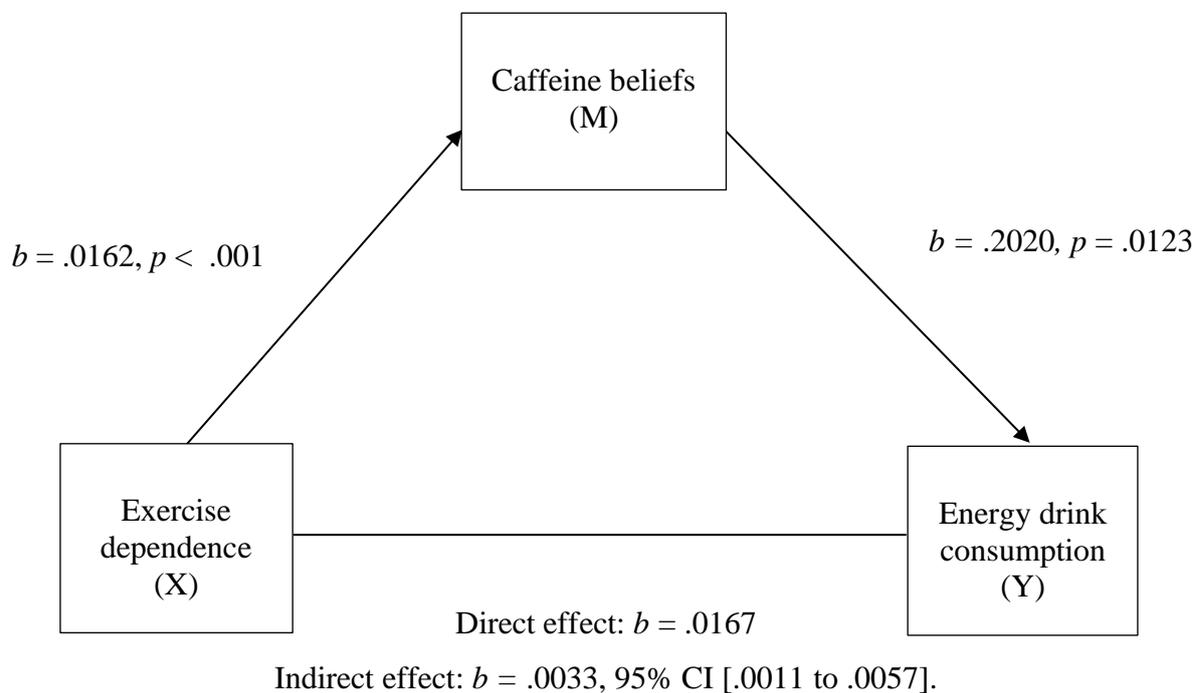
** $p < .01$

A process matrix was performed to examine the hypothesis that caffeine belief (mediator) would mediate the relationship between exercise dependence and energy drink consumption. As shown in Figure 4, there was a direct positive relationship between exercise dependence and energy drink consumption. For every score a participant scores on the exercise dependence scale (EDS-21), their energy drink consumption goes up 0.02, meaning that a person who scores 50 scores higher on the EDS-21 drinks one more energy drink. Also

shown in Figure 4 are that higher scores on the exercise dependence scale are associated with stronger caffeine beliefs and higher levels of caffeine beliefs are associated with higher levels of energy drink consumption. Lastly, as shown in the figure there was a significant, indirect effect between exercise dependence and caffeine beliefs, $b = .0033$, 95% CI [.0011 to .0057] suggesting that caffeine beliefs partially mediate the relationship between exercise dependence and energy drink consumption. This means that when taking the mediating effects of caffeine beliefs into account, a person needs to score a little less than 60 points on the EDS-21 to drink one average one more energy drink per day.

Figure 4

Exercise Dependence, Energy Drink Consumption and Caffeine Beliefs.



Note. Standardized regression coefficients for the relationship between exercise dependence (X), energy drink consumption (Y) and believing caffeine enhances athletic performance (M). The relationship between the variables is significant, $p < .05$.

Discussion

The aim of the present study was to gain a better understanding of the relationship between exercise dependence, energy drink consumption, and the mediating effect of believing caffeine enhances athletic performance. The study demonstrates a statistically significant relationship between higher scores on the exercise dependence scale (EDS-21) and higher energy drink consumption, partially explained by believing caffeine enhances athletic performance. Whereas past research has focused on athletes studying at university, revealing an exercise dependence prevalence of 7-10% (Lichtenstein & Jensen, 2016), the current study examined ordinary students at Reykjavik University in Iceland and found an exercise dependence prevalence of 0%. Since energy drink consumption has increased significantly (Gunja & Brown, 2012), the study provides beneficial knowledge on how exercise dependence and believing caffeine enhances athletic performance, influences energy drink consumption.

The hypothesis that higher scores on exercise dependence would be associated with higher energy drink consumption is supported. The results are somewhat consistent with previous findings that revealed that exercise dependence is associated with the use of performance-enhancing drugs (Lichtenstein, 2020). However, this study provides insight into the consumption of energy drinks, which might be considered a performance-enhancing drug, since previous findings have revealed that 80% of student-athletes use energy drinks to enhance athletic performance (Hoyte et al., 2013). The study also provides insight into how exercise dependence relates to the consumption of energy drinks. However, further research is needed to examine the relationship between exercise dependence and the consumption of energy drinks.

The current study reveals that higher scores on the exercise dependence scale

are significantly associated with believing caffeine enhances athletic performance. To the researchers' knowledge, previous studies have not examined the relationship between exercise dependence and caffeine beliefs before. Therefore, further studies are needed to interpret what this relationship indicates.

The hypothesis that the relationship between energy drink consumption and caffeine beliefs would be associated with believing caffeine enhances athletic performance is supported. The findings reveal that among those who drink more than one energy drink a day, 75% believe that caffeine enhances athletic performance, indicating that most university students might be consuming caffeine such as energy drinks to enhance athletic performance during physical exercise. The results are consistent with previous findings that have revealed that higher energy drink consumption is significantly associated with believing caffeine enhances athletic performance (Hunthley & Juliano, 2012). Other research has revealed that higher frequency and quantity of caffeine consumption is associated with greater expectancies for enhanced physical performance (Hunthley & Juliano, 2012). However, it is worth noting that previous research has often focused on general caffeine consumption, not energy drink consumption. Previous research (Jenný Harðardóttir, 2019) revealed that in 2019 the majority of Nocco's Instagram posts, a popular energy drink brand in Iceland, was related to exercise. The energy drink brand Ripped was also advertised with the words energy, fat burn and recovery. Further more, it is common that energy drinks are promoted through collaboration with athletes or other influencers. Therefore, it is not surprising that the current study reveals that higher energy drink consumption is associated with believing caffeine enhances athletic performance, when energy drinks marketing strategy is to associate their product with athletes and exercise.

Previous studies have supported that caffeine consumption can enhance athletic performance to a certain extent (Clarke et al., 2018; Wiles et al., 2006). However, they have

also linked caffeine consumption to reduced sleep quantity, and quality (Ramos-Campo et al., 2019) and possibly has adverse effects on exercise through impaired sleep (Myllymäki et al., 2011; Fullagar et al., 2015). The results of the current study, with consideration to previous findings about adverse effects of caffeine on sleep (Ramos-Campo et al., 2019), and negative effects of energy drinks on oral health (Sapna et al., 2020) give an idea that false and harmful advertisement of energy drinks is influencing energy drink consumption. This study provides important findings for future education to the public, coaches, and influencers about energy drink consumption.

The hypothesis that the relationship between exercise dependence and energy drink consumption would be mediated by believing caffeine enhances athletic performance is supported. Whereas previous research has revealed that beliefs about caffeine enhancing physical performance predicts high caffeine consumption (Huntley & Juliano, 2012; McIlvain et al., 2012), the current study provides insight into energy drink consumption and its relation to exercise dependence.

According to previous research, people who engage in competitive training such as ultra-marathons might be at a higher risk for exercise dependence (Szabo et al., 2013). However, the current study highlights that university students might be at a higher risk for not exercising enough, with 35% not having engaged in any physical exercise for the past three months. Among the university students who engaged in physical exercise for the past three months, 99% were considered asymptomatic for exercise dependence, indicating a mostly healthy relationship with exercise. However, the exercise dependence scale does not measure eating disorders or body dysmorphia symptoms. Therefore, the results do not guarantee that participants have a healthy relationship with exercise, even though they score low on exercise dependence.

Limitations and Future Research

There are at least four limitations concerning the results of this study. The first is that the continuance factor within exercise dependence should be interpreted with caution since one question is missing from the scale. The second limitation is that the question about beliefs was about caffeine enhancing athletic performance, not energy drinks. Since energy drinks often contain vitamins, branched-chain amino acids (BCAAs), collagen and other ingredient associated with athletic performance, it would be beneficial to study beliefs about energy drinks, not just caffeine. Future studies could as well examine whether people consume caffeine to maintain a baseline of performance rather than enhancing it, due to frequent and excessive caffeine consumption resulting in withdrawal and tolerance to the enhancing effects. The third limitation is that the covid pandemic might have influenced the findings, affecting people's exercise habits and energy drink consumption. At last, it is worth noting that the current study was a cross-sectional study and can therefore not evaluate a causal relationship between exercise dependence, energy drink consumption and caffeine beliefs. However, the study supports that there is a relationship between the variables.

In the light of the current studies' limitations, and that this is one of the first research examining exercise dependence and energy drink consumption with an Icelandic sample, it would be beneficial for future research to examine both exercise dependence and energy drink consumption among athletes and the public among Icelanders. Future studies could examine exercise dependence and energy drink consumption among gym members at WorldFit at Worldclass Iceland. A part of WorldFits's equipment is advertised by Nocco, a popular energy drink brand in Iceland, and could therefore influence gym members' energy drink consumption. It could also be beneficial to examine general caffeine consumption, and symptoms of exercise dependence among Iceland's bodybuilding and bikini fitness competitors since previous findings have revealed that those in competitive training might be at a higher risk for exercise dependence (Lichtenstein & Jensen, 2016; Szabo et al., 2013). It

might also be beneficial to determine people's knowledge about caffeine and its adverse effects. Whether they are aware of energy drinks' possible adverse effects on organs and oral health, and the recommended daily dose of caffeine. The current study revealed that 33% consumed their last amount of caffeine after 2 pm. Therefore, it could be beneficial to examine whether people are aware of afternoon consumption of caffeine and its effect on sleep quality.

Conclusion

Although the generality of the current results must be established by future research, the present study provides insight into beliefs about caffeine enhancing athletic performance influencing energy drink consumption. This study suggests that the closer one is to being exercise dependent, the higher their energy drink consumption. The results also indicate that interventions aimed at changing attitudes towards the positive effects of energy drink consumption on athletic performance may reduce energy drink consumption and, hence reduce or prevent the potential adverse health problems associated with energy drink consumption.

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