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Cover Page Footnote

We would like to thank Dr. Annmarie Burns (lecturer, MTU) and Dr. Brigid Lucey (Head of Department of Biological Science, MTU) for their constant support and guidance throughout the process of completing this paper. We would also like to thank Frances O'Sullivan (BSc (Hons) Children's and General Integrated Nursing) who provided unending guidance and editing of this paper. Correspondence: Gavin Buckley: gavin.buckley1@mycit.ie

An Investigation into Caffeine Consumption and Self-Reported Dependency in the Republic of Ireland

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ABSTRACT

Objectives: To explore the consumption of caffeine containing beverages by the Irish population and to investigate their self-perceived dependency on such products.

Methodology: An online survey was distributed with national access to Irish adults which was open to responses from 25th February to 7th March 2021 inclusive. A total of 417 responses from participants over 18 years of age was validated and analysed using Microsoft Excel.

Results: Tea was the most commonly consumed caffeinated product among the Irish population, with the majority of respondents stating their consumption began before 10 years old. The majority of respondents did not believe themselves to be dependent on caffeine; however their self-reported intake could imply otherwise. Reports of withdrawal symptoms and evidence showing a lack of awareness regarding the presence of caffeine in certain regularly consumed beverages were noted.

Conclusion & Recommendations: Caffeine is widely consumed throughout the Irish population. An association between self-reported dependency and higher caffeine intake per day was noted. The Irish population could be made more aware of caffeine content in products, which can be achieved through improved labelling of such goods. Result of this study suggest the potential benefit of educating the public on caffeine dependence syndrome and the risks associated with high levels of caffeine consumption. Introducing a legal age for purchasing highly caffeinated products could be considered. The lack of standardised unit measurements and the bias of self-reported data presented limitations in this study.

INTRODUCTION

Caffeine is a widely consumed psychoactive drug whose popularity has significantly increased in recent years due to its ability to stimulate and energise consumers, while also promoting enhanced mood and alertness (Dias *et al.*, 2015; Heckman *et al.*, 2010). The most common sources of caffeine in beverages include coffee, black tea (caffeinated), energy drinks (e.g. Red Bull®, Monster Energy®) and Coca-Cola® (Mitchell *et al.*, 2014).

In a paper published by Heckman *et al.* (2010), it is stated that in an average 8oz (240ml) cup, caffeine content is as follows: instant coffee – 93mg, black tea – 47mg, Coca-Cola® – 23mg, energy drinks – 76-80mg. Both hot chocolate and decaf tea/coffee contain 3.2mg of caffeine per 8oz (Nicholson, 2008). It must be emphasised that caffeine content can vary considerably between cups of tea or coffee due to factors such as brewing time, different strengths and brands (Heckman *et al.*, 2010). While coffee has been found to be the major source of caffeine in Europe and the United States, tea is the most frequently consumed caffeinated beverage in Ireland (Verster & Koenig, 2018).

Caffeine dependence syndrome is recognised by the World Health Organisation, who utilise the International Statistical Classification of Diseases and Related Health Problems (10th Revision) (ICD-10) for diagnosis (Meredith *et al.*, 2013). ICD-10 lists 9 criteria for the diagnosis of the disorder, which are the same diagnostic criteria used for mental and behavioural disorders caused by usage of drugs including alcohol, opioids, cocaine and tobacco (WHO, 2016).

The signs and symptoms of caffeine dependence syndrome, i.e. withdrawal symptoms, generally become apparent within 24 hours of cessation or reduction of caffeine intake (APA, 2013). These symptoms include headache, fatigue, drowsiness, depressed mood, irritability, difficulty concentrating, and flu-like symptoms such as nausea, vomiting and muscle pain.

The purpose of the current study was to assess the role of caffeine in Ireland, the attitude of the Irish population towards caffeinated beverages, and the dependency of this population on such products.

METHODOLOGY

Survey Population

A questionnaire was drawn up consisting of a series of questions distributed to the students of University College Cork, along with various businesses and organisations. Individuals aged 18 and over and resident in the Republic of Ireland were asked to participate in this anonymous survey. Ethical approval was granted by module coordinators on behalf of MTU following submission of an application for ethical approval using the MTU ethics application form.

Survey Questions

An online survey was created using Google Forms which comprised 25 questions consisting of both open and closed ended formats. To avoid bias, an equal number of options was put either side of a neutral response in any questions where a level of agreement or disagreement was required.

Distribution

The survey was disseminated via social media, primarily Facebook and WhatsApp, and email. The survey was open to responses from 25th February to 7th March 2021 inclusive.

Data Analysis

The data collected from this survey were analysed using Microsoft Excel and interpreted through the creation of pivot tables and subsequently pie charts, bar charts and tables. Separate spreadsheets were created for each research question and answers were analysed both independently and in conjunction with other relevant data obtained.

RESULTS

Responses And Demographics

A total of 423 responses was recorded from the Google Forms survey. Respondents who do not consume any form of caffeine (six respondents) were excluded. Therefore, this survey produced 417 valid responses which could be analysed, whose demographics are shown in Table 1. Due to technical issues encountered on some mobile devices for question 9 (analysed in Figure 2), a

further 120 responses had to be discounted for analysis of this question only, leaving 297 valid responses to be analysed for this question alone.

Table 1: Survey Population Demographics.

Gender	**% & number of respondents**
Female	74% (n=307)
Male	26% (n=110)
Age group	**% & number of respondents**
18-20	12% (n=51)
21-25	18% (n=74)
26-35	13% (n=54)
36-45	13% (n=54)
46-55	26% (n=109)
56+	18% (n=75)
Occupation	**% & number of respondents**
Employed	
Educator	16% (n=68)
Administrator	16% (n=66)
Healthcare	7% (n=28)
Other	24% (n=101)
Student	
Second level	6% (n=23)
Third level	20% (n=82)
Retired	6% (n=26)
Other	5% (n=23)

Consumption

Most Regularly Consumed Caffeinated Product

Participants were asked which caffeine containing product they consumed most regularly, with responses presented in Figure 1. A total of 45% (n=186) consumed tea most regularly, with 42% (n=174) stating that they consume coffee most often.

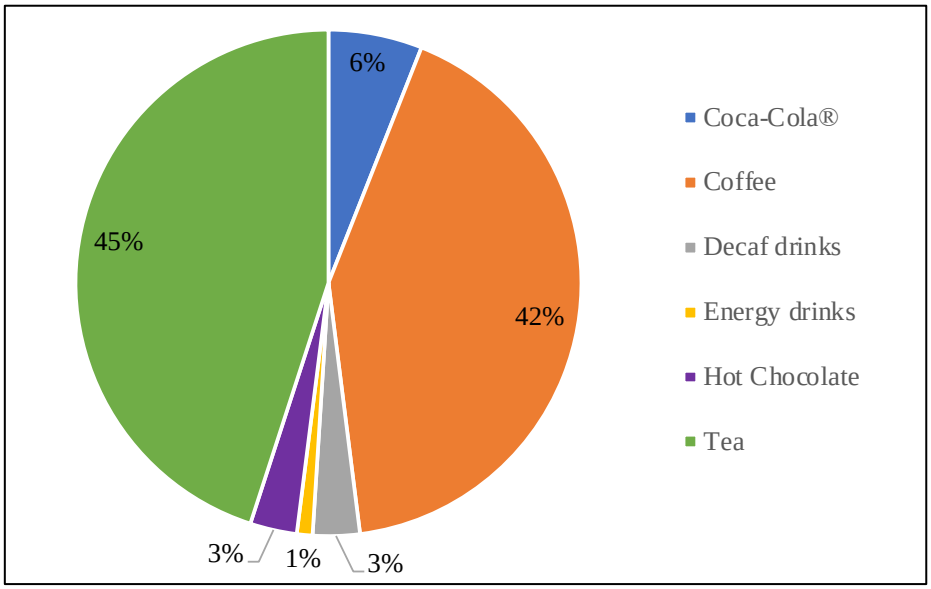

Figure 1: Determination of the Most Commonly Consumed Caffeine Containing Products in the Irish Population.

Reasons For Participants' Consumption Of Caffeine Products

Table 2 displays all relevant reasons why respondents consume caffeine, chosen from a series of predetermined options. Taste was the most common reason for caffeine intake across the majority of the caffeine products in question. Other reasons stated by participants as to why they consume caffeine included for enjoyment and warmth.

Table 2: Reasons for Participants' Consumption of Caffeine Products.

Reason for consuming caffeine	% & number of respondents
For taste	64% (n=268)
Out of habit	51% (n=211)
For social reasons	44% (n=185)
To combat tiredness/fatigue	34% (n=141)
To relax	33% (n=136)
To increase productivity	17% (n=72)
Other	2% (n=10)

Respective Age At Which Participants Began Consuming Individual Caffeinated Products

Figure 2 shows the age range at which participants began consuming individual caffeine products. Of those who consumed tea, 47% (n=140) began at less than 10 years. The same trend can be seen for hot chocolate (59%; n=175) and Coca-Cola® (48%; n=142). Of those who consumed coffee, 37% (n=109) began when they were between the ages of 16-20 years. With regards to energy drinks, 19% (n=55) began consumption when they were 16-20 years. *It should be noted that analysis of this question was based on a total of 297 valid responses due to a technological error.

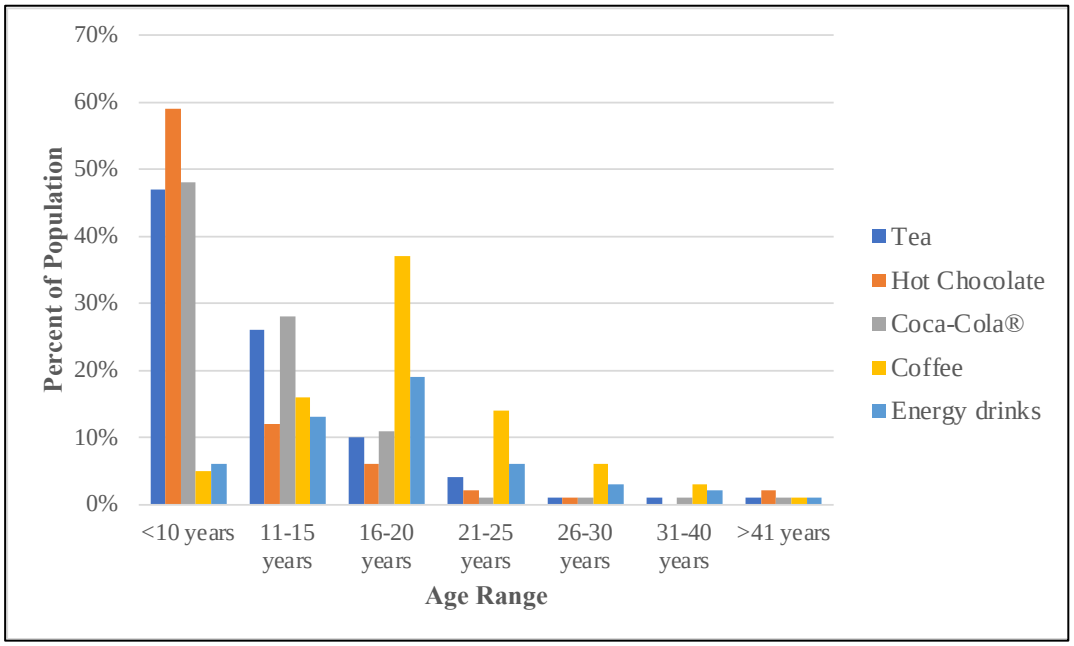

Figure 2: Age at Which Participants Began Consuming Caffeine Containing Products Among an Irish Population.

Amount (Units) of Each Caffeine Product Consumed by the Irish Population

Participants were asked how many units (cups/cans) of caffeinated products they consume per day. As shown in Figure 3, the majority (45%; n=188) of respondents stated they consume 2-3 units per day, with 30% (n=125) consuming 4-5 units per day. A total of 17% (n=71) consume 0-1 units a day, with 8% (n=33) having more than six units daily. The majority of those who consume 6+ units of caffeine daily are tea drinkers.

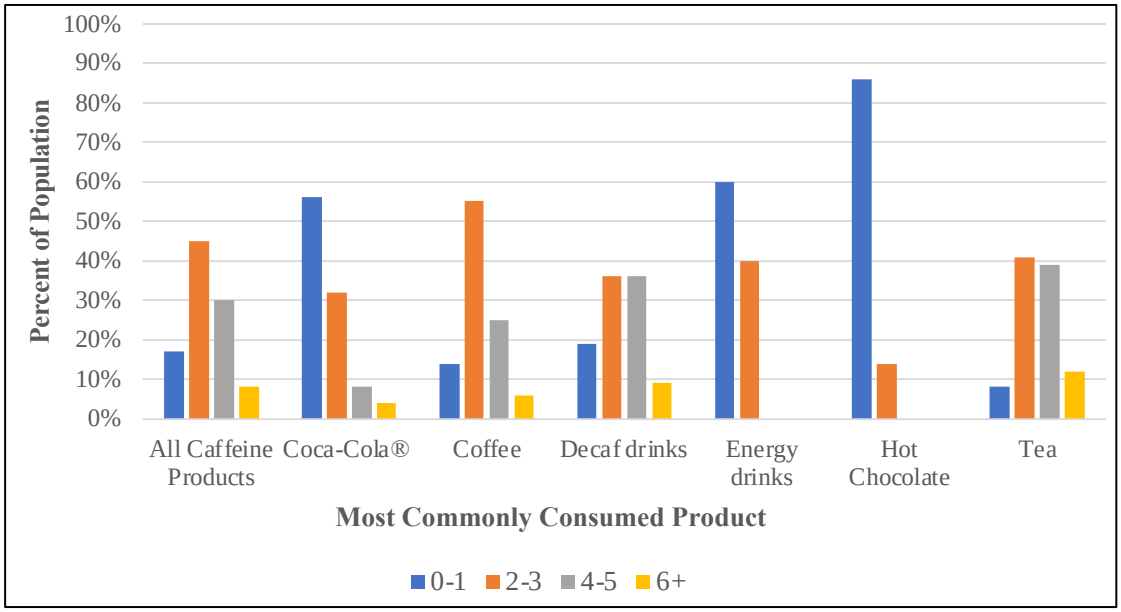

Figure 3: Units of Caffeine Containing Products Consumed Based on Product.

Addiction And Dependency

Immediate Effect Of Caffeine Consumption On Participants

Participants were asked, out of a series of options, to select how they felt immediately after consuming caffeine. One hundred and twenty eight participants (31%) experienced an uplift in mood and 27% (n=111) felt more relaxed, whilst 22% (n=91) felt more energised immediately after caffeine consumption. In terms of the negative effects of caffeine, 4% (n=17) felt 'jittery' after consuming caffeine, whilst 2% (n=8) experienced heightened anxiety. A total of 47% of participants (n=198) observed no change immediately after caffeine consumption.

Self-Recognised Dependency Of Participants On Caffeine Based On Most Regularly Consumed Caffeine Product

Figure 4 highlights participants' perception of their dependency on caffeine products on a scale of 1 to 5 – one being not dependent at all, and five being very dependent. When analysing all caffeine products, 34% (n=143) said that they were not dependent at all, 24% (n=99) self-reported being a 2 on the scale, 22% (n=91) were a 3, 14% (n=57) were a 4 and 6% (n=24) said that they were a 5 – very dependent on caffeine products. This trend was observed across the different products, except for coffee and energy drinks. The largest group of coffee drinkers (27%, n=46) said that they were a 3 (neither dependent nor not dependent).

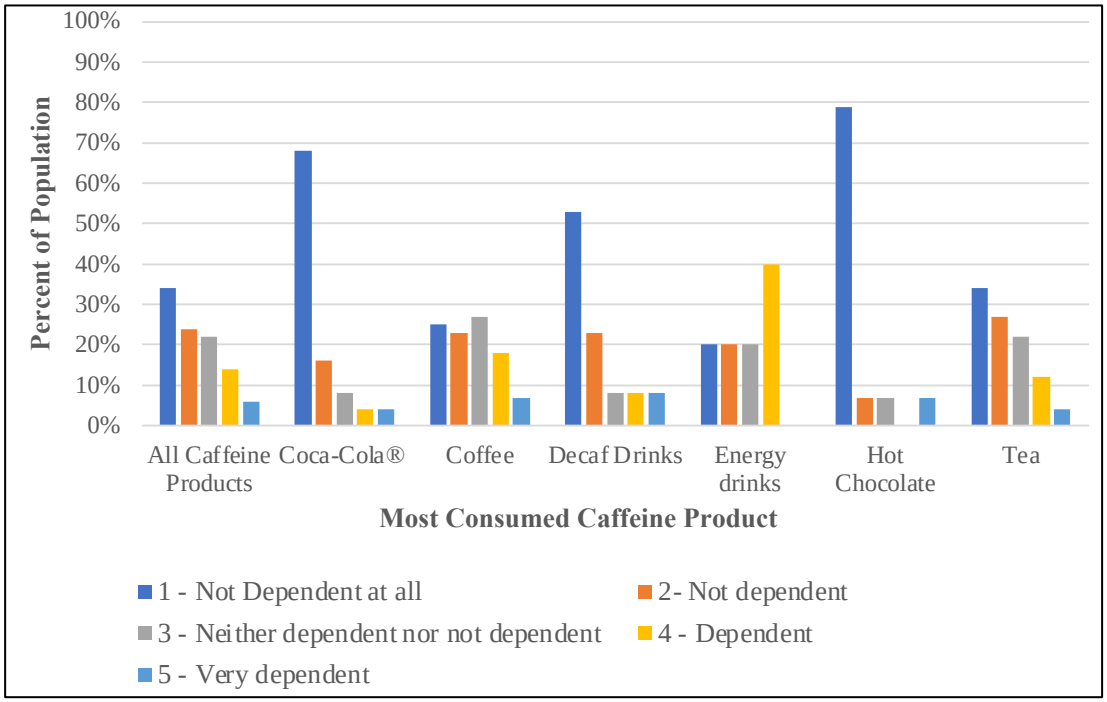

Figure 4: Participants' Degree of Dependency on Caffeine Based on Most Regularly Consumed Caffeine Product.

Degree Of Respondents' Dependency Based On Amount Of Consumption

The participants' self-reported dependency was compared to the average units they consume, as shown in Table 3.

Table 3: Degree of Dependency Based on Consumption.

Degree of Dependency	All Respondents	Average Units Consumed (Cups/Cans)			
		0-1 (n=70)	2-3 (n=188)	4-5 (n=123)	6+ (n=35)
1 - Not Dependent at all	34% (n=142)	78% (n=54)	35% (n=65)	14% (n=17)	17% (n=6)
2- Not dependent	24% (n=100)	11% (n=8)	29% (n=54)	27% (n=33)	14% (n=5)
3 - Neither dependent nor not dependent	22% (n=92)	11% (n=8)	19% (n=36)	32% (n=39)	26% (n=9)
4 - Dependent	14% (n=58)	0% (n=0)	13% (n=25)	20% (n=25)	23% (n=8)
5 - Very dependent	6% (n=25)	0% (n=0)	4% (n=8)	7% (n=9)	20% (n=7)

Reduction Of Caffeine Intake And Respective Effects On Participants

Participants were asked if they had ever tried to reduce their caffeine intake and to describe any effects they experienced. A total of 36% of the 417 participants (n=149) attempted to reduce their caffeine intake. Reasons for this included the cost, for health reasons, and to improve sleep quality. Of these 149 participants, 17% (n=26) suffered headaches upon reducing their caffeine intake, 7% (n=11) experienced reduced energy levels, and 9% (n=14) had improved sleep. In addition, 26% (n=38) experienced no change when reducing their caffeine intake whilst 15% (n=23) stated that their caffeine intake did not remain reduced. Two participants reduced their caffeine intake for health reasons and found that their recurrent heart palpitations ceased, whilst another found that their flu-like symptoms had reduced.

Public Perception

Participants' Awareness Of Caffeine Containing Products

Participants were asked to state whether or not they thought particular products contained caffeine. Every product listed contained caffeine. Analysis of 417 participants found that 65% (n=273) were unaware of the presence of caffeine in hot chocolate, whilst 75% (n=314) were unaware of its presence in decaf coffee/tea. A total of 7% (n=29) were unaware of the presence of caffeine in Coca-Cola®. Over 95% of participants were aware of the presence of caffeine in coffee, tea, and energy drinks. Before this question, 4% (n=16) of respondents claimed they did not consume caffeine. When informed that all of the products listed contained caffeine, all 16 participants then stated that they do, in fact, consume a caffeinated product of some form.

Perceived Social Acceptance Of Caffeine Dependency

When asked if participants thought caffeine dependency was socially acceptable, 68% (n=283) of respondents believed it was, while 8% (n=35) did not and 24% (n=99) were unsure.

DISCUSSION

This study was carried out with the intention of understanding the role of caffeine in Irish society and evaluating the caffeine products most commonly consumed by the Irish population. Survey demographics highlighted a well distributed age range which was predominately female.

The current study found that the primary caffeinated beverages consumed among the surveyed population were tea (45%) and coffee (42%) respectively (Fig. 1). These results were in line with a recent literature review stating that tea is the principal source of caffeine in Ireland (Verster & Koenig, 2018). Hot chocolate, energy drinks and Coca-Cola® were found to be lesser sources of caffeine among the Irish population in the current study, thereby supporting this review.

The results of the current study were in stark contrast with an American study carried out by Drewnowski & Rehm (2016), who noted coffee as the most commonly consumed caffeine product at 64% of the total respondents, followed by tea at 18%. As the current study focused on Irish residents, a discrepancy based on cultural standards must be taken into account. Residents of the Republic of Ireland have been found to drink the most tea *per capita* in the world, 6 times higher than the global average (Waugh *et al.*, 2016).

Survey respondents were provided a list of possible reasons for their consumption of caffeinated beverages and asked to choose all of which were true for them (Table 2). The most commonly answered reason was due to the taste, which was selected by 64% of participants, and was consistent with a number of previous studies (Turton *et al.*, 2016; Bunting *et al.*, 2013). In total, 34% believed caffeine consumption helped to combat fatigue, an effect which has been previously documented (Heckman *et al.*, 2010). Of this 34%, 56% were primarily coffee drinkers. In contrast, tea was consumed most regularly by those who drink caffeine to relax.

A total of 17% of respondents consume caffeine to increase productivity. Caffeine has been associated with improved alertness, awareness and concentration, all of which result in increased productivity (Mitchell *et al.*, 2014; Heckman *et al.*, 2010). One individual noted caffeine as a means of weight loss. This is possibly due to an increased resting metabolic rate following consumption of caffeine (Higdon & Frei, 2006).

Participants were also asked the ages at which they began consuming each of the stated caffeine products (Fig. 2). The majority of individuals began drinking tea, hot chocolate and Coca-Cola® under the age of 10 years. This is similar to a 2014 study conducted by Branum *et al.* in the United States where fizzy drinks and tea were found to be commonly consumed in children and adolescent age groups. In the current study, 41% of participants stated that their preferred caffeine product had changed over time. The majority of these participants drank tea as a child and switched to coffee in their teenage years, mainly between 16 and 20 years. Coffee was the most widely consumed amongst the 18-20 and 36-45 age groups. Tea was the most regularly consumed amongst the other age groups, with the exception of those aged 46-55, where tea and coffee were equally consumed.

In addition, this study investigated the effects that participants experienced immediately after consuming caffeine. The most prevalent effect experienced was an uplift in mood which was common across each caffeine product. However, to continually experience this 'uplift' would require participants to consume more caffeine, as depicted in a previous study which stated that repeated caffeine intake eventually causes serotonergic neurons to undergo adaptive changes, reducing the conversion of tryptophan to 5-hydroxytryptamine, potentially triggering depression in conditions of caffeine withdrawal (Haleem *et al.*, 1995). A trend found in the current study was that participants who felt more energised or 'jittery' after caffeine consumption tended to consume coffee and energy drinks, whereas those who felt more relaxed or experienced no change after caffeine consumption tended to consume tea. While the difference in these effects is likely due to the larger caffeine content in coffee/energy drinks compared to tea (Heckman *et al.*, 2010), a study conducted by Quinlan *et al.* (2000) noted the immediate effect of caffeine ingestion may be due to a conditioned response. This suggests

that the effects experienced by participants in the current study could be due to the outcome desired by that individual (coffee/energy drink needed before an exam, or tea ingested late in the evening before bed) rather than the direct effect of the caffeine.

According to WHO (2016), the nine criteria set out by ICD-10 for the diagnosis of caffeine dependence syndrome are acute intoxication, harmful use, dependence syndrome, withdrawal state, withdrawal state with delirium, psychotic disorder, amnesic syndrome, residual and late-onset psychotic disorder, other mental and behavioural disorders and unspecified mental and behavioural disorders. The American Psychiatric Association (APA) included caffeine dependence syndrome in the Diagnostic and Statistical Manual of Mental Disorders (5th Edition) (DSM-5) as a condition for further study. DSM-5 proposed a number of criteria for diagnosis of caffeine dependence syndrome including "a persistent desire or unsuccessful efforts to cut down or control caffeine use… continued caffeine use despite knowledge of having a persistent or recurrent physical or psychological problem that is likely to have been caused or exacerbated by caffeine" and "withdrawal, as manifested by either of the following: (a) the characteristic withdrawal syndrome for caffeine, (b) caffeine (or a closely related) substance is taken to relieve or avoid withdrawal symptoms" (APA, 2013, p.792-793).

Considering this, the current study asked participants to rate their own perceived dependence on caffeine containing products on a scale of 1 to 5 – one being not dependent at all, and five being very dependent. The results of this were interpreted with regard to the most commonly consumed product (Fig. 4) and with regard to the units of consumption (Table 3). It was found that the more units consumed by an individual per day, the more likely they were to identify as dependent or very dependent. This is in line with a recent study which stated that the severity of withdrawal symptoms has been found to increase as the daily dose increases (Sajadi-Ernazarova *et al.*, 2020).

The current study determined that those who consumed coffee most regularly were more likely than tea drinkers to identify as dependent or very dependent, due to the fact that coffee contains one psychoactive substance, caffeine, while tea contains four known psychoactive substances – caffeine, L-theanine, theobromine and theophylline (Li *et al.*, 2020; Nobre *et al.*, 2008). These four substances work together to produce a stimulated response, known as alert relaxation (Nobre *et al.*, 2008). This 'response' from caffeine alone, as in coffee, is a more wired feeling, which consumers associate more with consumption of caffeine products (Haskell *et al.*, 2007). This may account for the differences in self-perceived dependency between tea and coffee consumption found in this study.

Participants were asked what symptoms they experienced when trying to reduce their caffeine intake. The most prevalent symptom was a headache, followed by reduced energy levels. Some participants experienced flu-like symptoms. These symptoms were in line with another study conducted on caffeine withdrawal syndrome where the seven prevalent factors were noted as fatigue, low alertness, mood disturbances, low sociability, nausea, flu-like feelings, and headache (Juliano *et al.*, 2012). An interesting note in the current study was that two participants' recurrent heart palpitations ceased when their caffeine intake was reduced. The underlying cause of these arrhythmias may be the elevated homocysteine levels upon caffeine consumption (Katan & Schouten, 2005).

Furthermore, this study tested participants' knowledge on the presence of caffeine in a variety of beverages to assess the public awareness of caffeine containing products. The majority of participants failed to recognise the presence of caffeine in hot chocolate and decaf coffee/tea. Another notable trend was the lack of awareness of caffeine in Coca-Cola®. This finding takes precedence when considering caffeine consumption amongst children, unbeknownst to themselves or their parents. In a previous study of Caffeinated Sugar Sweetened Beverages (CSSBs) consumption in Icelandic children conducted by Kristjansson *et al.* (2014), it was found that 19% of boys and 8% of girls aged 10-12 years consume cola drinks daily. Whilst the public awareness of caffeine in energy drinks is well known, as established by the current study, Kristjansson *et al.* found that 7% of boys and 3% of girls aged 10-12 consume energy drinks daily. CSSB use was associated with headaches, stomach aches, sleeping problems, and low appetite in these children with a higher incidence after energy drink consumption compared to cola drink consumption (Kristjansson *et al.*, 2014). This lack of public awareness of

caffeinated products may lead to children consuming a larger amount of caffeine than otherwise expected.

In addition to the aforementioned physical complaints that may arise in children, another concern is that these caffeine drinks could put obese children at further risk of cardiac dysrhythmias and intracardiac conduction abnormalities (Seifert *et al.*, 2011). The elevated risk of hypertension from increased caffeine consumption in children could exacerbate cardiac conditions such as hypertrophic cardiomyopathy (Seifert *et al.*, 2011).

Finally, survey participants were asked if they thought a caffeine addiction was socially accepted, of which 68% believed it was. One recent study found that coffee and tea are the most consumed and socially accepted stimulants in the world with 90% of adults consuming caffeine daily (Bordeaux & Lieberman, 2020). When examining individual opinions on the topic, many stated that such an addiction is not as harmful or stigmatised as other addictions, e.g. alcohol or drug addiction.

Many people view caffeine as a "fashionable" way of socialising when meeting friends for a coffee or inviting someone over for tea. As a society, consuming caffeine is almost expected and people are often surprised if somebody does not drink caffeine in any form. However, this also depends on the caffeine type, as energy drink consumption is not as widely accepted. Many believe an age limit should be put in place to limit purchases of highly caffeinated products such as energy drinks to prevent excessive caffeine consumption by children, as was recommended by Gibson-Moore & Valentine (2007) in their study which sought to limit energy drink consumption in American schools.

In conclusion, caffeine is widely consumed throughout the Irish population in various forms and, as demonstrated in this study, self-reported dependency was associated with higher caffeine intake per day. It is clear that a greater knowledge of the addictive nature of caffeine needs to be provided to the Irish population. Additionally, caffeine content and information on caffeine dependence syndrome should be made clear to the population, in the form of campaigns and better labelling of caffeine products.

The possibility of increasing the legal age needed to purchase highly caffeinated products such as energy drinks should be examined, considering the adverse effects that caffeine can have on developing children and adolescents.

Study limitations included the omission of standardised unit measurements, which made evaluation and comparison of participants' caffeine consumption difficult. Self-reported data are subject to bias which may also have occurred in this study.

Further studies which could be carried out in this field include an investigation into the long term effects of consuming caffeinated products, as well as social pressure surrounding caffeine consumption.

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