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Prevalence of Metabolic Syndrome among Caffeinated Energy Drinkers (Case-Control Study)

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بِسْمِ اللهِ الرَّحْمنِ الرَّحِيمِ

﴿ قُلۡ هَلۡ يَسۡتَوِي ٱلَّذِينَ يَعۡلَمُونَ وَٱلَّذِينَ لَا يَعۡلَمُونَۗ إِنَّمَا يَتَذَكَّرُ أُوْلُواْ ٱلۡأَلۡبَٰبِ ﴾

(الزمر: ٩)

﴿بڵێ، ئایا ئەوانەی دەزانن یەکسانن لەگەڵ ئەوانەی کە نازانن بەڕاستی تەنها خاوەنانی ژیریی ئامۆژگاری وەردەگرن﴾

(تەفسیری پوختە)

Say, "Are those who know and those who do not know equal?" Indeed, only those endowed with understanding remind themselves.

(Bridges Foundation)
Interpretor: Fadel
Soliman

Certification

I certify that this project was prepared under my supervision at the Department of Biomedical Sciences, Collage of Applied Sciences, Cihan University-Erbil as a Partial Requirements for the degree of:

Bachelor of Science

In

Biomedical Sciences

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Date: / / 2025

Certification

We, the examining committee, certify that we have read this project and have examined the students in its contents and that in our opinion it is adequate as a partial requirement for the degree of:

Bachelor of Science

In

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List of Abbreviation

Abbreviation	Explanation
ED	Energy Drink
TC	Total Cholesterol
TG	Tri glycerol
LDL	Low Density Lipoprotein
HDL	High Density Lipoprotein
HDL-C	High Density Lipoprotein Cholesterol
BP	Blood Pressure
FBS	Fasting Blood Sugar
BMI	Body Mass Index
WHO	World Health Organization
NCEP	National cholesterol education program
EFSA	European Food Safety Authority
NHNES	National Health and Nutrition Examination Survey
IDF	International Diabetes Federation
SSB	Sugar-sweetened beverages
CVD	Cardiovascular disease
T2DM	Type two Diabetes Miletus
NAD^+	Nicotinamide Adenine Dinucleotide
NADH	Nicotinamide Adenine Dinucleotide Hydrogen
MetS	Metabolic Syndrome
Mfg.	Manufacture

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Abstract

Background: The energy drinks industry has experienced significant growth over recent years, with numerous brands available globally and its consumption reached 4.8 billion liters in 2011. These beverages are known for providing an extra burst of energy, promoting wakefulness, enhancing attention, maintaining alertness, and improving athletic performance. Energy drinks are liquid products that generally contain caffeine, sometimes combined with additional dietary supplements. Previous studies have found that regular consumption of these beverages is linked to various health and behavioral issues. Such as metabolic syndrome which is characterized by the presence of multiple major cardiovascular disease (CVD) risk factors, including high blood pressure, elevated blood sugar levels, increasing in body mass index and dyslipidemia.

Methodology: This case-control study investigated the effects of energy drink consumption on various metabolic parameters and other physiological problems among 50 participants divided into two groups 30 cases and 20 controls aged between 18-34 years. The entire research project was completed in five months. The parameters were divided into Lipid profile, Hypertension, Fasting blood sugar, Body mass index, and questionnaires for Sleep cycle, Mood swing, and Appetite changes.

Results: This research found non-significant outcomes of lipid profile parameters: Total cholesterol ($p = 0.469$) Triglycerides ($p = 0.304$) LDL Cholesterol ($p = 0.185$) HDL Cholesterol ($p = 0.304$), and regarding to physiological parameters results was: blood pressure ($p = 0.573$), fasting blood sugar ($p = 0.937$), The findings were mixed, revealing both significant and non-significant correlations such as FBS and BMI ($p = 0.937$, $r = 0.011$), Triglyceride and BMI ($p = 0.312$, $r = 0.146$) Cholesterol and BMI ($p = 0.477$, $r = -0.103$) HDL and LDL ($p = 0.102$, $r = -0.234$) .

Conclusions: The research yielded several significant and non-significant findings regarding both metabolic syndrome, physiological and behavioral aspects of energy drink consumption. The results of this research were confirmed by other researches, however some results were non-identical with the parameters metabolic syndrome.

Key words: Energy drinks, Caffeine, Metabolic syndrome, Lipid profile, Body mass index, Sleep cycle, Mood swing, Appetite changing.

CHAPTER ONE

1.0. Introduction

1.1. Energy drinks

Energy drinks are beverages designed to provide an enhance cognitive function and mood (Ishak et al., 2012). These drinks typically contain a combination of caffeine, taurine, glucuronolactone, vitamins, herbal extracts, proprietary blends, and/or amino acids, and are marketed for their purported benefits in mental alertness and physical stamina (Higgins et al., 2018). Energy drink consumption has become a global public health concern, particularly among adolescents and young adults. A substantial increase in energy drink consumption has been observed in recent decades, especially in Western and Asian countries (Ibrahim & Iftikhar, 2014).

1.2. Energy Concerns

Concerns exist regarding the potential contribution of energy drinks to rising trends in overweight, obesity, and cardiometabolic conditions in young people (Trapp et al., 2020). Metabolic syndromes, a common metabolic disorder, is associated with the increasing prevalence of obesity. While definitions vary, a new, globally applicable definition is anticipated. The pathophysiology of this syndrome is largely attributed to insulin resistance, excessive fatty acid flux, and a likely proinflammatory state. Given the increased risk for type 2 diabetes and cardiovascular disease, therapeutic intervention is crucial for high-risk individuals. The primary approach involves weight reduction and increased physical activity; however, pharmacological treatment may be appropriate for diabetes and cardiovascular disease risk reduction. (Eckel et al., 2005) Serum lipid profile analysis has become a routine clinical test, typically performed in a fasting state due to limitations associated with non-fasting samples (Nigam, 2011). For many years, the standard lipid profile (total, LDL, and HDL cholesterol, and triglycerides) has been determined using blood specimens collected after an overnight fast (Rifai et al., 2016). Body mass index (BMI) is a cornerstone of current obesity classification systems, widely used in various contexts from international surveillance to individual patient assessment. However, BMI, like other anthropometric measurements, is a surrogate for body fatness. Obesity is defined as excessive body fat accumulation, and the degree of excess fat correlates with adverse health outcomes (Prentice & Jebb, 2001). A BMI between 20 and 22 is considered ideal, associated with longevity and minimal

illness incidence. A BMI over 30 indicates an unhealthy condition, placing individuals at risk for heart disease, stroke, diabetes, hypertension, and certain cancers, necessitating weight loss through dietary and exercise modifications (Fontana, L., & Hu, F. B. 2014). Hypertension is a prevalent, chronic, age-related disorder often associated with debilitating cardiovascular and renal complications. Blood pressure is typically assessed in conjunction with other cardiovascular risk factors, and hypertension diagnosis increasingly relies on automated blood pressure measurement techniques. (Staessen et al., 2003).

1.3. Important of the research

1. Public Health Concern:

- Rising Consumption of Energy Drinks: The study addresses the increasing global consumption of energy drinks, which has become a public health concern, especially among adolescents and young adults. Energy drinks are often marketed as enhancing mental alertness and physical stamina, but their potential health risks are not well understood by the general public.
- Health Risks: The research highlights the potential health risks associated with energy drink consumption, including metabolic syndrome, cardiovascular issues, and behavioral changes. This is crucial for informing public health policies and regulations regarding the sale and marketing of energy drinks, particularly to younger populations.

2. Behavioral and Psychological Effects:

- Sleep Cycle Disruption: The study found a significant association between energy drink consumption and irregular sleep patterns. Poor sleep quality is linked to a range of health issues, including impaired cognitive function, mood disorders.
- Mood Swings and Appetite Changes: The research also explores the impact of energy drinks on mood and appetite, finding that caffeine and other ingredients in energy drinks can lead to mood swings and altered appetite patterns. This is particularly important for understanding the psychological effects of energy drinks on young consumers.

3. Youth and Adolescent Health:

- Target Demographic: The study focuses on individuals aged 18-34, a demographic that is particularly vulnerable to the marketing of energy drinks. Adolescents and young adults are more likely to consume these beverages without fully understanding the potential health risks.
- Educational Implications: The findings underscore the need for educational campaigns to raise awareness about the potential dangers of energy drink consumption, especially among younger populations. This could help reduce the prevalence of energy drink-related health issues in this age group.

1.4. Aim of research

The aim of research is to examine the high prevalence of energy drink consumption among adolescents and teenagers, with particular focus on its potential physiological and psychological implications. This research seeks to evaluate the effects of energy drinks that contain high sugar amount can affect on metabolic parameters, specifically hyperlipidemia, blood glucose levels and blood pressure. Additionally, the study aims to assess the relationship between energy drink consumption and anthropometric measures, including body mass index and appetite regulation. Furthermore, this investigation will examine the impact of the caffeine content in energy drinks on circadian rhythm disruption and mood alterations in young consumers.

1.5. Gaps of the research

1. The sample size was relatively small.
2. The study was conducted over a short period of time.
3. The sampling process involved multiple exclusions to ensure and obtain accurate results.
4. Dealing with volunteers to be fasting at least 8 to 12 hours was challenging and difficult.

CHAPTER TWO

2.0. Literal review

2.1. Prevalence and history of energy drinks

Energy drinks are beverages that typically contain caffeine, taurine, glucuronolactone, vitamins, herbal extracts, proprietary blends, and/or amino acids, and marketed as boosting mental alertness and physical stamina. They are available with or without sugar and may or may not be carbonated, thus the range of products is broad. (Higgins et al., 2018). Energy drinks (EDs) first debuted in Austria in 1987, and then in North America in 1997. Their composition mainly contains carbohydrates, vitamins, minerals, and most importantly, caffeine and taurine. (Mihaiescu et al., 2024). Energy drinks have no therapeutic benefit, and many ingredients are understudied and not regulated. The known and unknown pharmacology of agents included in such drinks, combined with reports of toxicity, raises concern for potentially serious adverse effects in association with energy drink use. (Seifert et al., 2011). Large quantities of caffeine, taurine, sugars, and B-vitamins may be contributing to these outcomes by increasing the heart rate, blood pressure (BP), and contractility of the heart in addition to prolonging the QTc. There is still a substantial amount of unknown information on EDs that warrants more research and a dire need for age regulations, transparency of ingredients, clear labeling of adverse effects, and most importantly, education of consumers. (Kaur et al., 2022). Consumption of sugar-sweetened beverages (SSBs) among adolescents is an important public health issue worldwide (Sampasa-Kanyinga et al., 2018).

The metabolic syndrome (visceral obesity, dyslipidemia, hyperglycemia, and hypertension), has become one of the major public-health challenges worldwide. (Abda et al., 2016). Metabolic syndrome, variously known also as syndrome X, insulin resistance, etc., is defined by WHO as a pathologic condition characterized by abdominal obesity, insulin resistance, hypertension, and hyperlipidemia. (Saklayen, 2018).

2.1.1. Energy drinks

The term "energy drink" designates "any product in the form of a drink or concentrated liquid, which claims to contain a mixture of ingredients having the property to raise the level of energy and vivacity. (Petit et al., 2012). Energy products have exploded in popularity in the past several years; however, their use is not without risk. Caffeine is the main active ingredient in energy drinks, and excessive consumption may acutely cause caffeine intoxication, resulting in tachycardia, vomiting, cardiac arrhythmias, seizures, and death. The effects of chronic high-dose caffeine intake in children and adolescents are unknown. Caffeine may raise blood pressure, disrupt adolescent sleep patterns, exacerbate psychiatric disease, cause physiologic dependence, and increase the risk of subsequent addiction. (Wolk et al., 2012).

2.1.2. Composition of energy drinks

Most of energy drinks in our markets contain (Caffein, Taurin, Sugar, Vitamin B and other ingredients. (table 2.1). (Ehlers et al., 2019).

(Table. 2.1.) shows Most popular energy drinks and ingredients per 500 ml.

Energy Drink	Caffeine (mg)	Sugar (g)	Other Ingredients
Red Bull	160	54	Taurine (2000 mg) vitamins B3, B5, B6 and B12
Monster	160	54	Taurine (2000 mg), and vitamins B2, B3, B6 and B12
Rockstar	160	62	Taurine (2000 mg), vitamins B2, B3, B5, B6 and B12

2.1.2.1. Caffein

Caffeine (1,3,7-trimethylxanthine) is a natural alkaloid found in coffee beans, tea leaves, cocoa beans, yerba mate and many other plants (Nawrot et al., 2003). In addition, caffeine may in certain cases be added to a variety of different foods, such as bakery products, ice cream, sweets, soft drinks and also (EDs). The European Food Safety Authority (EFSA) has published positive scientific opinions on the substantiation of health claims related to caffeine in association with mental and physical performance, whereby the positively assessed effect depends on the ingested dose of caffeine. (Ehlers et al., 2019). Reports of caffeine toxicity from energy drink consumption are increasing, particularly among adolescents, warranting review and regulation of the labelling and sale of these drinks. Educating adolescents and increasing the community's awareness of the hazards from energy drinks is of paramount importance. (Gunja & Brown, 2012).

2.1.2.2. Effects of caffeine

Caffeine is absorbed and passes quickly into the brain. It does not collect in the blood stream or get stored in the body. It leaves the body in the urine many hours after it has been consumed. There is no nutritional need for caffeine. It can be avoided in the diet. Caffeine stimulates, or excites, the brain and nervous system. (Rodak et al., 2021).

2.1.2.3. Side effects of caffeine

Side effects of caffeine include: (Wolde, 2014).

- Anxiety
- Depression
- Difficulty sleeping
- Nausea Restlessness Tremors
- A fast heart rate
- Poly urea
- Drowsiness
- Headaches
- Irritability
- Nausea, and vomiting

2.1.2.4. The effects of Caffeine on sleep quality

Pharmacologically, caffeine is an adenosine-receptor antagonist. As such, it appears that the effects of caffeine on performance occur largely through its occupation of adenosine receptors. It acts primarily on A1 and A2A receptors, which in turn are related to functions of the brain associated with sleep, arousal, and cognition. Caffeine is efficiently and quickly absorbed by the stomach and small intestine, with peak plasma levels occurring in the first 30 min. (O'Callaghan et al., 2018). Large cross-sectional studies, such as (Orbeta et al) examination of 15,686 American adolescents, find that after adjusting for socioeconomic factors, students reporting high caffeine intake are more likely to be tired in the morning than those reporting very low intakes. Caffeine's reputation as a performance stimulant that can reverse the deficits associated with fatigue means that it is often ingested by those who are fatigued, at the same time as being implicated in causing the fatigue in the first place. (O'Callaghan et al., 2018).

2.1.2.5. The effects of Caffeine on mood

Many people rely on caffeine because of its effects. The primary purpose of the current study was to measure the effects of caffeine on current mood state, the effects of caffeine on mood dependent upon time of questionnaire administration, how caffeine and mood interact to impact attention and distraction, and if this varied by gender. Prolonged use of caffeine can lead to physical dependence evidenced by characteristic withdrawal symptoms during abstinence. Debate exists as to whether mood enhancement by caffeine represents a net effect or merely the restoration of abstinence-induced mood decrements. One aim of this study was to determine the net effects on mood of dietary caffeine compared with prolonged abstinence. (Williams et al., 2010).

2.2.1. Taurine

Taurine (2-aminoethanesulfonic acid; $NH_2CH_2CH_2SO_3H$) is a non-essential amino acid, not participating in protein synthesis because it is devoid of a carboxyl group.

2.2.1.1. Effect of Taurine health

Taurine has many physiological effects on human body health as we mention below:

2.2.1.1.1. Effect of Taurine Cardio Vascular System

Taurine, the most abundant, semi-essential, sulfur-containing amino acid, is well known to lower blood pressure (BP) in hypertensive animal models. However, no rigorous clinical trial has validated whether this beneficial effect of taurine occurs in human hypertension or prehypertension, a key stage in the development of hypertension. Taurine has several potentially beneficial cardiovascular effects that involve regulation of the nitric oxide system and endothelial function, the renin–angiotensin–aldosterone system, the oxidative stress system and sympathoadrenal activity. (Wu & Prentice, 2010).

2.2.1.1.2. Taurin and energy Metabolism

Taurine deficiency-mediated impairment of complex I activity also affects energy metabolism, largely through elevations in the $NADH/NAD^+$ ratio, which regulate energy metabolism by feedback inhibiting key dehydrogenases. The citric acid cycle is very sensitive to increases in the $NADH/NAD^+$ ratio, as three NADH sensitive enzymes (α-ketoglutarate dehydrogenase, isocitrate dehydrogenase and citrate synthase) are subject to inhibition by elevations in the $NADH/NAD^+$ ratio. (Wu & Prentice, 2010).

2.2.1.3. Glucose

Glucose is a 6-carbon structure with the chemical formula $C6H12O6$. Carbohydrates are ubiquitous energy sources for every organism worldwide and are essential to fuel aerobic and anaerobic cellular respiration in simple and complex molecular forms. (Hantzidiamantis et al., 2024).

2.2.1.3.1. Impacts of glucose on health

The body is designed to utilize carbohydrates - where a physiological balance of ingestion, storage and utilization is critical. In disease states, the balance is lost and a number of carbohydrates based metabolic disorders are established within the medical community. (Qi & Tester, 2019).
Main health issues related with glucose intake include:

2.2.1.3.2. Obesity

Obesity can be described as the accumulation of adipose tissue. The definition of obesity is based on the body mass index (BMI), which is calculated as weight in kilograms divided by height in meters squared (kg/m2). Obesity is defined as a BMI greater than 30 kg/m2, and overweight is defined as a BMI from 25–30 kg/m2. It is important to remember that, although BMI correlates with the amount of body fat, BMI does not directly measure body fat. (Sweatt et al., 2024).

The influence of obesity on type 2 diabetes risk is determined by the degree of obesity and also by where fat accumulates. Increased upper body fat, including visceral adiposity as reflected in increased abdominal girth or waist-to-hip ratio, is associated with the metabolic syndrome, type 2diabetes, and cardiovascular disease. (Eckel et al., 2011).

2.2.1.3.3. Diabetes Mellitus

Insulin regulates glucose metabolism by direct and indirect actions. Through binding to its receptors in the liver, kidney, muscle, and adipose tissue, insulin activates its signaling pathway Diabetes is a chronic illness characterized by elevated levels of blood glucose, accompanied by disturbed metabolism of fats and proteins. Blood glucose rises because it cannot be metabolized in the cells, due to lack of insulin production by the pancreas or the inability of the cells to effectively use the insulin that is being produced. There are three major types of diabetes: (1) Type 1, in which the pancreas does not produce insulin; (b) type 2 in which the body cells are resistant to the action of insulin that is being produced and over time the production of insulin progressively decreases; and (c) gestational diabetes which occurs in pregnancy and can cause some complications during the pregnancy, and at birth and increases the risk of type 2 diabetes in the mother and obesity in the offspring. Uncontrolled diabetes leads to complications in many organs. Damage to small and large blood vessels and nerves leads to loss of vision and kidney function, heart attacks, strokes, and lower limb amputations. Diabetes causes disability and shortens lives. (Nowak et al., 2018).

2.2.1.3.4. Hyperlipidemia

Hyperlipidemia causes abnormally elevated levels of lipids and lipoproteins in the blood including total cholesterol, triglycerides and is a lipid metabolism disorder. Hyperlipidemia can significantly enhance the risk of cardiovascular diseases such as coronary artery disease, atherosclerosis, cerebrovascular disease and peripheral vascular disease. In addition, hyperlipidemia may result in solid organ injury, including damage to the liver and kidneys. High-fat diet induces the development of intra-abdominal fat deposits and hepatic steatosis and plays an important role in the improvement of insulin resistance and increasing glucose levels and causes hyperinsulinemia (Nelson, 2013).

2.3. Metabolic syndrome (MetS)

Metabolic syndrome, variously known also as syndrome X, insulin resistance, etc., is defined by WHO as a pathologic condition characterized by abdominal obesity, insulin resistance, hypertension, and hyperlipidemia. (Saklayen, 2018). The presence of three abnormal findings out of five components qualifies a person for the metabolic syndrome: elevated waist circumference, elevated triglycerides, reduced high-density lipoprotein cholesterol, elevated blood pressure and elevated fasting plasma glucose. (Nilsson et al., 2019).

2.3.1. Etiology of metabolic syndrome

The underlying etiology of metabolic syndrome is multifactorial. The proposed causes include genetic predisposition and multiple environmental or lifestyle factors, including obesity, lack of physical activity, and unhealthy dietary habits. (Swarup et al., 2024).

2.3.2. Epidemiology metabolic syndrome

The global incidence of metabolic syndrome rises almost parallel to the incidence of obesity. According to the National Health and Nutrition Examination Survey (NHNES), the prevalence of metabolic syndrome in adults increased from 25.3% to 34.2% in 2012. The survey further revealed that the South Asian American population had a very high incidence of metabolic syndrome, albeit a lower prevalence of obesity as compared to non-Hispanic white men and women. The prevalence of metabolic syndrome peaked at the start of the 21st century in the U.S. (Swarup et al., 2024).

2.3.3. Pathophysiology metabolic syndrome

The pathophysiology of the MetS encompasses several complex mechanisms that are yet to be fully elucidated. It is still debated as to whether the different elements of MetS form by themselves distinct pathologies or fall under a common, broader pathogenic process. In addition to genetic and epigenetic factors some lifestyle and environmental such as overeating and lack of physical activity have been identified as major contributors to the development of MetS. A causative role can be given to high caloric intake since visceral adiposity has been shown to be an important trigger that activates most of the pathways of MetS, Among the proposed mechanisms, insulin resistance, chronic inflammation, and neurohormonal activation seem to be essential players in the progression of MetS and its subsequent transition to CVDs and T2DM. (Fahed et al., 2022).

2.3.4. Five conditions associate with metabolic syndrome

the American Heart Association/ National Heart Lung and Blood Institute (Harmonization) and the International Diabetes Federation (IDF). Presence of any three of the following five conditions is essential as shown below: (Dash et al., 2022).

- Elevated waist circumference
- Elevated triglycerides (drug treatment for elevated triglycerides is an alternate indicator
- Reduced HDL-C (drug treatment for reduced HDL-C is an alternate indicator
- Elevated blood pressure (antihypertensive drug treatment in a patient with a history of hypertension is an alternate indicator
- Elevated fasting glucose
- HDL-C indicates high-density lipoprotein cholesterol.

2.3.5. Lifestyle modification

As described earlier, MetS results from increased calorie consumption disproportionate to metabolic requirements. Lifestyle modification is imperative in the management of underlying risk factors. Weight reduction and maintenance of ideal body weight are essential preventive and management strategies. The goal of weight reduction is a loss of 7–10% in baseline body weight over a period of 6–12 months as well as a reduction of caloric intake by 500–1000 calories/day. Dietary modification can also regulate other MetS components: low intake of saturated fats, trans fats, cholesterol, sodium, and simple sugars is known to help with dyslipidemia, hyperglycemia

and hypertension, for example. Diets high or very low in fat content exacerbate atherogenic dyslipidemia, as such, 25– 35% of daily caloric intake in the form of fat is usually recommended. Judicious use of bariatric surgery has shown benefit in the morbidly obese. Weight reduction helps with improvement in all components of exercise. Exercise increases calorie consumption, aiding weight loss and reducing overall CVD risk: around 30–60 min of moderate intensity exercise and conscious efforts to alter a sedentary lifestyle can be beneficial for the management of MetS. (Rochlani et al., 2017).

2.3.6. Pharmacotherapy

Along with modifying the underlying risk factors, pharmacotherapy is another option for the prevention of CVD. Major pharmacological interventions include management of dyslipidemia with statins, decreasing prothrombotic risk with antiplatelet drugs, and the use of insulin sensitizers to decrease the risk of diabetes. There is no single drug therapy for MetS and currently available pharmacotherapy and associated comorbidities necessitate prolonged use of multiple medications, which is challenging for patients due to polypharmacy and reduced compliance. Thus, there is growing interest in the use of naturally occurring compounds in lowering the risk and progression of MetS though their effect on long-term cardiovascular outcomes and long-term compliance is unknown. (Rakha et al., 2022).

2.4. Link between Caffeinated energy drink and appetite

Appetite is the feeling that you want to eat food. energy intake following food or supplement consumption can also relate to their impact on gastric emptying and diet induced thermogenesis as reduced hunger and enhanced satiety were reported to be linked with delayed gastric emptying (Wang et al., 2008) and with higher diet induced thermogenesis. (Fatima et al., 2015). Coffee and caffeine consumption has global popularity. However, evidence for the potential of these dietary constituents to influence energy intake, gut physiology, and appetite perceptions remains unclear. the evidence regarding coffee and caffeine’s influence on energy intake and appetite control. The literature was examined for studies that assessed the effects of caffeine and coffee on energy intake, gastric emptying, appetite-related hormones, and perceptual measures of appetite. The literature review indicated that coffee administered 3–4.5 h before a meal had minimal influence on food and macronutrient intake, while caffeine ingested 0.5–4 h before a meal may suppress acute energy

intake. Evidence regarding the influence of caffeine and coffee on gastric emptying, appetite hormones, and appetite perceptions was equivocal. The influence of covariates such as genetics of caffeine metabolism and bitter taste phenotype remain unknown; longer controlled studies are needed. (Schubert et al., 2017).

CHAPTER THREE

3.0. Materials and methods

3.1. Materials

The instruments and equipment which were used in this research are listed in Table 3.1.

Table (3.1.): shows the instruments and equipment's list which were utilized.

No.	Apparatus name	Company	Mfg.	Purpose of use
1.	Gloves	Alpha-med	UAE	Sterilization/Protection
2.	Disposable syringe	Ying-med	China	Taking blood sample
		Power health		Measure volume of sample
3.	Gel & clot activator tubes	ALFA-med	Europe/USA	Storing blood sample
4.	Micropipettes	Dragon medical ltd	China	Collect of blood sample
5.	First aid strips	Kudo health	China	Stopping Blood Puncture site
6.	Rossmax X1	Rossmax	Taiwan	Monitoring blood pressure
7.	Vivachek ino	Vivachek	China	Monitoring blood glucose
8.	Cobas C311	Roche diagnostics	USA	Testing chemistry analysis
9.	Rotofix 32 a	Hettich centrifuges	Germany	Separating blood contents
10.	Refrigerator	Arcelik	Turkey	Keeping the samples cold
11.	Cooler box	Kish termoos	Iran	Keeping the samples cool
12.	Mi smart scale 2	Xiaomi	China	Weighting the participants
13.	Seca 213	Seca	Germany	Measuring length of participants

3.2. Methods

3.2.1. Design of the study

The study was designed to measure in those whom are at risk of metabolic syndrome, the population of the study consisted of 50 participants were some from Cihan University-Erbil students and some other participants as well, from the 50 sample: 30 were case and 20 were control for the comparation study samples. The summarized design of the study shown in (Figure 3.1.)

3.2.2. Parameters of the study

Parameters of the study was deigned to measuring of lipid profile tests (total cholesterol low density lipoprotein, high density lipoprotein, triglycerides), blood pressure, Fasting blood sugar, measure of body mass index, and questioners for (sleep cycle, mood swing and changing in appetite).

3.2.3. Selection methods of participants

Participants were selected based on their energy drink consumption habits, with specific criteria focusing on the duration, frequency of use and their age. The duration (a minimum of six months) and frequency (at least 250 milliliters per week consistently). And age of consumers was between (18-34) years old.

3.2.4. Sampling techniques and procedures

samples were drown from the veins using conventional phlebotomy techniques, using single-use needles, five milliliters of blood samples were extracted and places inside a SST tube (Golden tube) then the tubes were placed inside a cooler box filled with ice to prevent damage to the samples and sometimes in the refrigerator as well, then the serum was separated by centrifugation (ROTOFIX 32 A) at 5000 rpm for five minutes, after the serum were separated they were places inside a chemical analyzer device (Cobas C311) to give us the result report. Then measured fasting blood sugar using glucometer (Vivachek ino) and (Rossmax X1) is automated digital used for blood pressure. Body Mass Index (BMI) is determined using the formula [BMI = Weight (kg) ÷ Height² (m^2)[, where Weight is recorded in kilograms and Height is measured in meters and then squared.

3.2.5. Study population

The Participants in the study comprised a purposive of sample of 30 case and 20 control individuals, whom were in males and females and both groups did not exhibit any clinical signs or symptoms of disease.

3.2.6. Duration of study

The data collection period lasted from October 12, 2024, to December 19, 2024. The entire research project was completed on February 13, 2025.

3.2.7. Setting of study

The investigation was carried out at Floria Laboratory in Erbil City in order to make the medical diagnosis.

3.2.8. Inclusion and exclusion criteria in the study

Inclusion criteria are included: males and females at risk of energy drink on metabolic syndrome, without any diseases or family history of any disease. Exclusion criteria are included males and females with any disease or family history of disease.

Table (3.2.): This table shows the duration of use of energy drinks participants (a minimum of 6 months and a maximum 8 years).

Characters	**Label**
20 Control	Non energy drinker (Must)
30 Case	Energy drinker Duration of use: 6 Months-8 Years

Table (3.3.): This table shows the amount of use of energy drinks (at least 250-1500 milliliters per week on a regular basis).

Characters	**Label**
20 Control	Non energy drinker (Must)
30 Case	Energy drinker Amoun of using: 250-1500 ml weekly.

Process and procedures of study

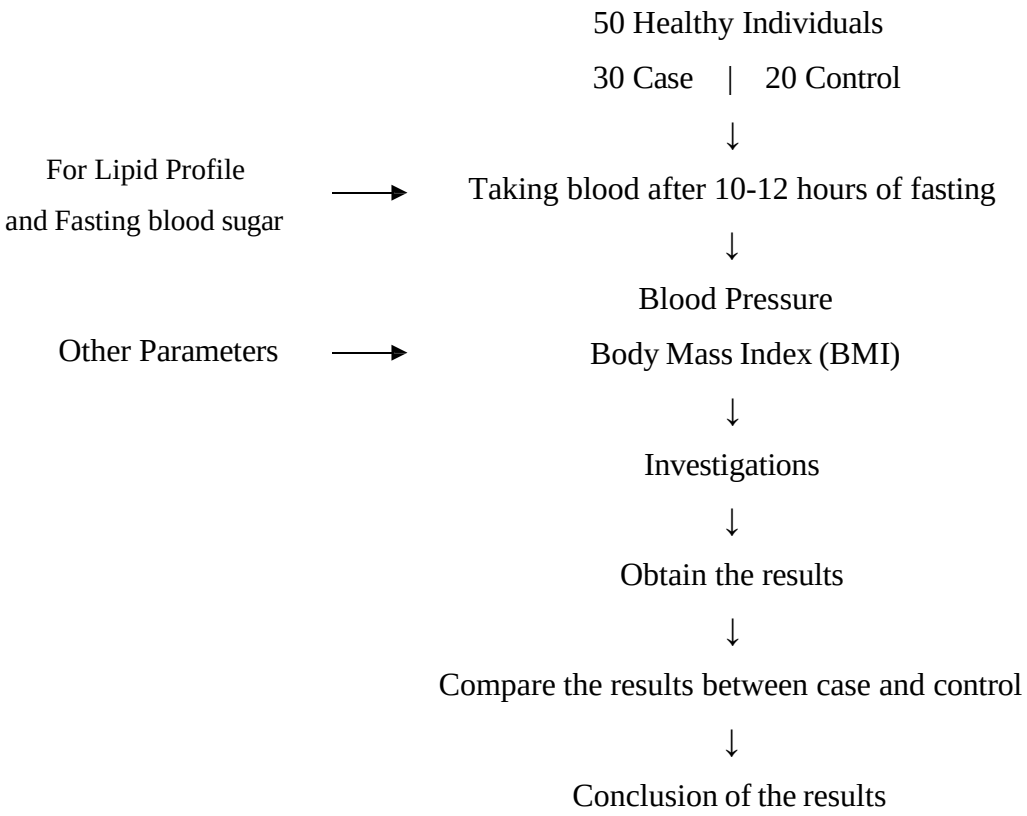

Figure 3.1: This diagram shows the design the study by diagram based on procedures.

CHAPTER FOUR

4.0. Results

4.1. Comparison and results of Lipid profile parameters

The table provides a summary of key lipid profile parameters, including their normal ranges and comparative data between two groups: "Case" and "Control." The parameters listed are Cholesterol, Triglyceride (TG), Low-Density Lipoprotein (LDL), and High-Density Lipoprotein (HDL). Each parameter is accompanied by its normal range, the number of participants in each group, and the mean values with standard deviations. The normal ranges for the parameters are as in (Table 4.1).

Parameter	Normal range/unit	Group	No.	Mean ± Std. Deviation	P value
Cholesterol	150-200 mg/dL	Case	30	155.493 ± 34.8261	0.469
		Control	20	154.255 ± 30.0869	
Triglyceride	40-140 mg/dL	Case	30	91.267 ± 43.3212	0.304
		Control	20	97.935 ± 58.2831	
LDL	65-170 mg/dL	Case	30	90.473 ± 31.5414	0.185
		Control	20	92.667 ± 21.1838	
HDL	35-170 mg/dL	Case	30	47.173 ± 12.4623	0.304
		Control	20	44.688 ± 11.8173	

(Table 4.1.): displays a comparison of lipid parameters between cases and controls. The parameters include Cholesterol, triglyceride, LDL and HDL, their values are presented as mean ± standard deviation (Std) for both groups, with reference ranges provided. Statistical significance is determined through P-values, with a significance threshold of 0.05. The analysis indicates non-significant differences between the cases and control groups in Cholesterol (P: 0.469), Triglyceride (P: 0.304), LDL (P: 0.185), and HDL (P: 0.304).

4.2. Comparison and results of physiological parameters

The analysis of physiological parameters revealed no statistically significant differences for either blood pressure (p-value: 0.573) or fasting blood sugar (p-value:.341), as shown in (Table 4.2.)

(Table 4.2.): presents two different physiological parameters and their corresponding p-values: Blood pressure: (p-value 0.573), Fasting blood sugar: (p-value: 0.341)

parameters	**Normal range/unit**	**P value**
Blood pressure	Systolic: 90 to 120 mmHg Diastolic: 60 to 80 mmHg	0.573
Fasting blood sugar	70 to 99 mg/dL	0.341

4.3. Comparison and the result of body mass index (BMI)

This research finds non-significant result between body mass index and energy drinkers (p-value 0.395). As shown in (Table 4.3.)

(Table 4.3.): This table shows the result of Body mass index (BMI): (p-value: 0.395).

parameters	**Normal range/unit**	**P value**
Body mass index	18.5-24.9 kg/m^2	0.395

4.4. Appetite

Among the case group 15 of participants 50% experienced boosted appetite, while 10 of participants 33.3% had suppressed appetite and only 0.0% (5) were not affected. Among the control group, 4 of participants 20% showed boosted appetite, while o 4 of participant 5% experienced suppressed appetite and appetite of 15 participants 75% were not affected. Statistical analysis showed a significant association between energy drink consumption and appetite changes as results shown in table (4.4.).

Table (4.4.): shows that caffeinated energy drinks affect appetite patterns.

Characteristics	**Cases** **No.**	**Controls** **No.**	**Total**	**P value**
Boosted	15 (46.7%)	4 (20%)	19 (42.0%)	
Suppressed	10 (33.3%)	1 (5%)	11 (36.0%)	< 0.001
Not experienced	5 (0.0%)	15 (75%)	20 (22.0%)	

4.5. Mood swing

Among the case group, 16 participant (53.3%) experienced changed mood swings, while 14 participant (46.7%) had no change in mood, and (0.0%) was not affected by it in the case group. Among the control group, 20% (4) showed no change in mood, while 0% experienced mood swings. The mood of 80% (16) were not affected. Statistical analysis showed the relationship between energy drink consumption and mood changes. Table (4.5.) shows that caffeinated energy drinks affect mood swings.

Table (4.5.): shows that caffeinated energy drinks affect mood swings.

Characteristics	**Cases** **No.**	**Controls** **No.**	**Total**	**P value**
Not changed	14 (46.7%)	7 (35.0%)	21 (42.0%)	
Changed	16 (53.3%)	2 (10.0%)	18 (36.0%)	< 0.001
Not experienced	0 (0.0%)	11 (55.0%)	11 (22.0%)	

4.6. Sleep cycle

Table (4.5.) Effect of caffeinated energy drinks on the sleep cycle, among the cases14 participants (46.7%) had regular sleep cycle, while 16 participants (53.3%) had irregular sleeping pattern. 0% were not affected by it in case group. Among the control group 7 participants (35.0%) had regulated sleep cycle while only 2 participants (10.0%) had irregular sleep cycle. The sleeping pattern of 11 participants (55%) were not affected. Statistical analysis showed a highly significant association between energy drink consumption and sleeping pattern (Table 4.6.).

Table (4.6.): shows sleeping pattern among cases and controls.

Characteristics	**Cases** **No.**	**Controls** **No.**	**Total**	**P value**
Regular	14 (46.7%)	7 (35.0%)	21 (42.0%)	< 0.001
Irregular	16 (53.3%)	2 (10.0%)	18 (36.0%)	
Not affected	0 (0.0%)	11 (55.0%)	11 (22.0%)	

4.7. Correlation Between FBS And BMI

Figure (4.1) Shows the correlation between fasting blood sugar level and body mass index. The Statistical analysis showed that there is no significant correlation between them (P value: 0.937), with a positive Pearson correlation coefficient of (0.011).

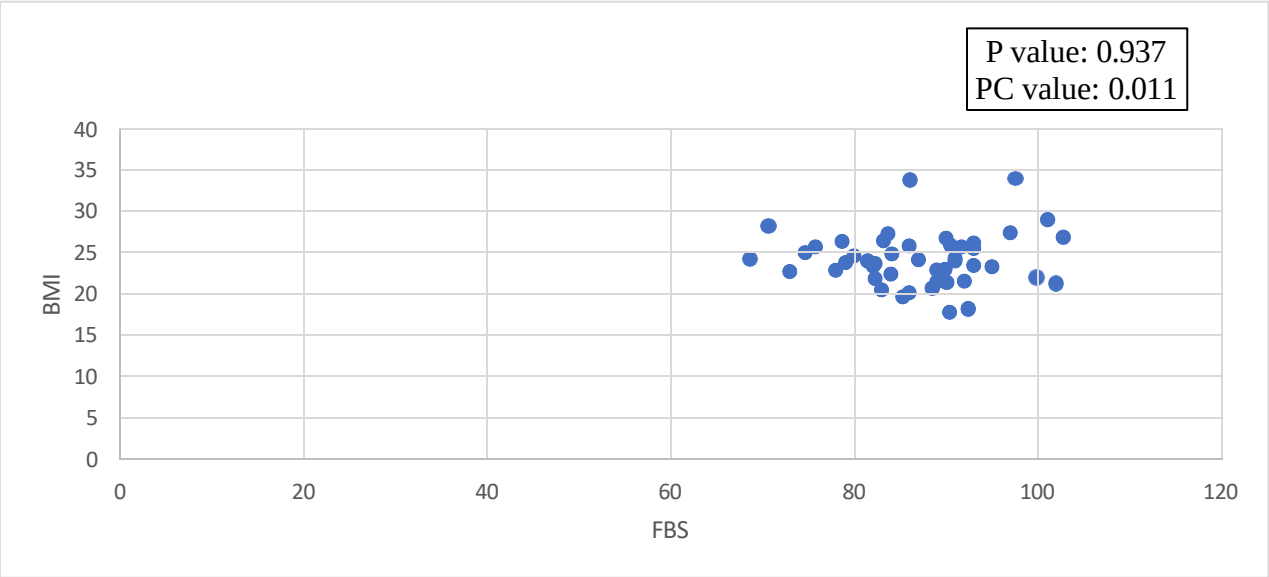

Figure 4.1: shows the correlation between Fasting blood sugar and body mass index.

4.8. Correlation between Triglyceride and BMI

Figure (4.2) Shows the correlation between Triglyceride and body mass index. The Statistical analysis showed that there is no significant correlation between them (P value: 0.312), with a positive Pearson correlation coefficient of (0.146).

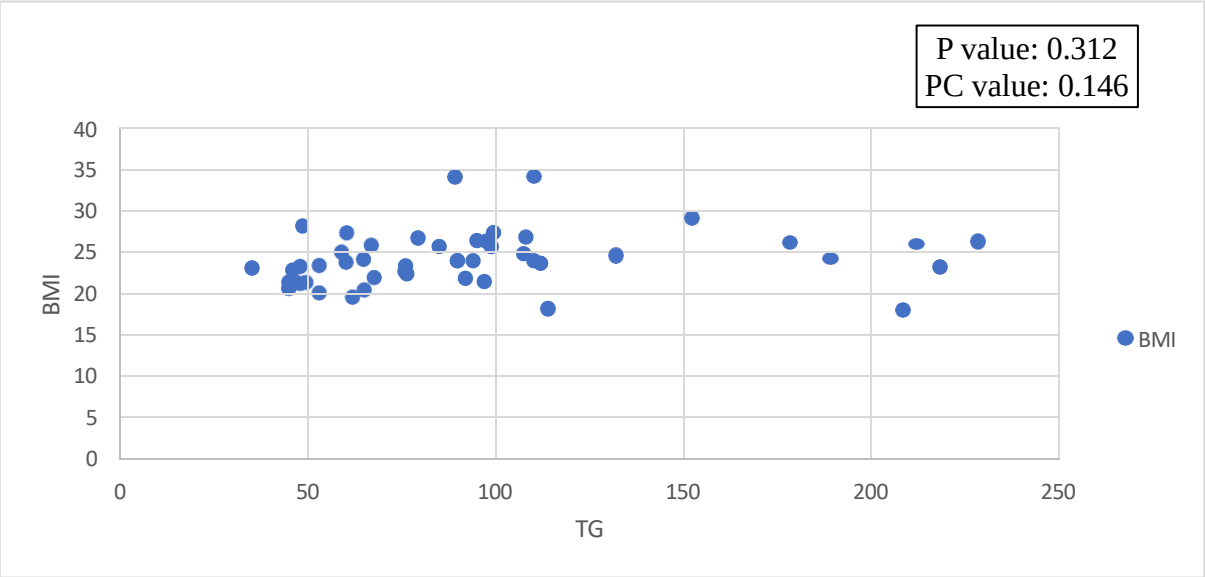

Figure 4.2: shows the correlation between Triglycerides and Body mass index.

4.9. Correlation between Cholesterol and BMI

Figure (4.3) Shows the correlation between Cholesterol level and body mass index. The Statistical analysis showed that there is no significant correlation between them (P value: 0.477), with a negative Pearson correlation coefficient of (-0.103).

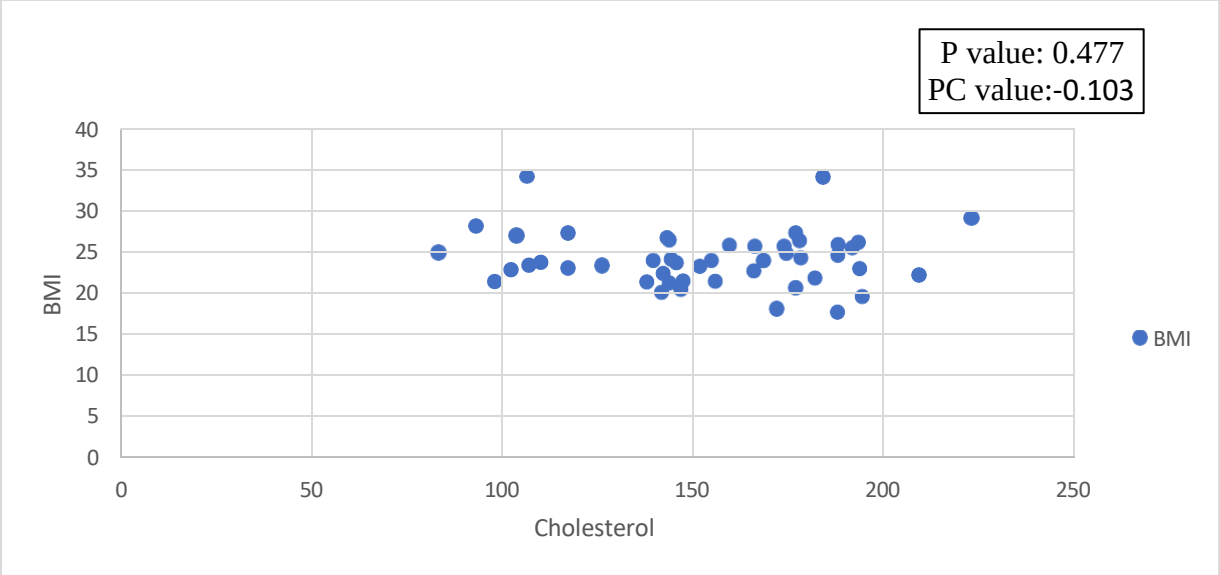

Figure 4.3: shows the correlation between cholesterol and body mass index.

4.10. Correlation between HDL and LDL

Figure (4.4) Shows the correlation between HDL And LDL. The Statistical analysis showed that there is no significant correlation between them P value (0.102), with a negative Pearson correlation coefficient of (-0.234).

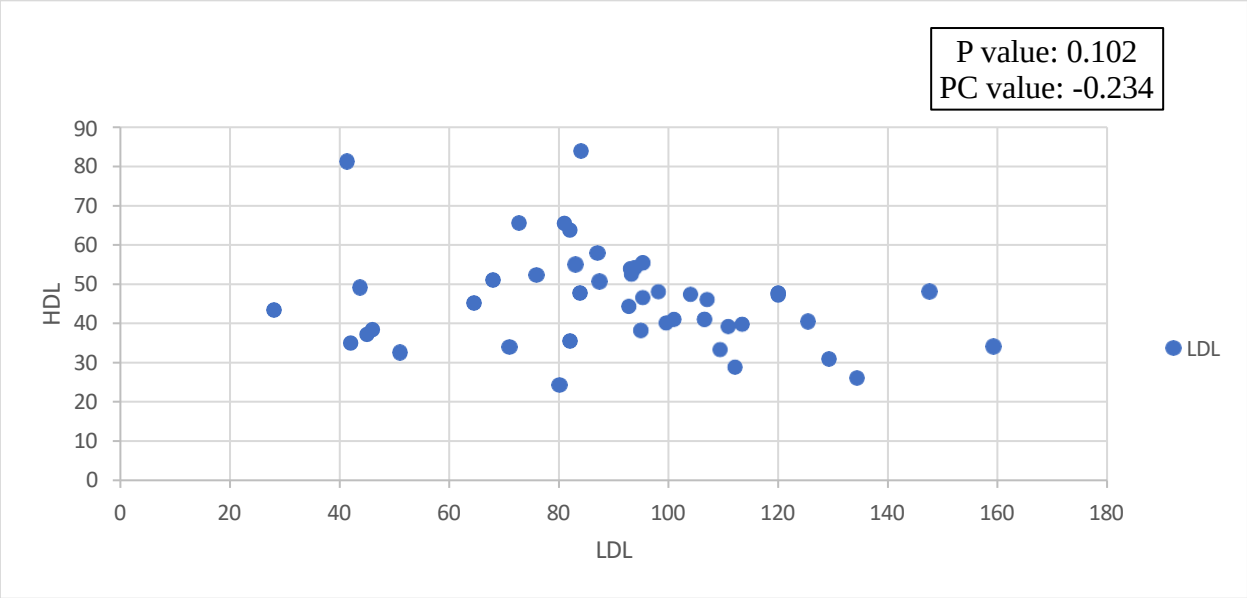

Figure 4.4: shows the correlation between high density lipoprotein and low-density lipoprotein.

4.11. Correlation between Triglyceride and Cholesterol

Figure (4.5) Shows the correlation between Triglyceride and Cholesterol. The Statistical analysis showed that there is no significant correlation between them P. value (0.001), with a positive Pearson correlation coefficient of (0.520).

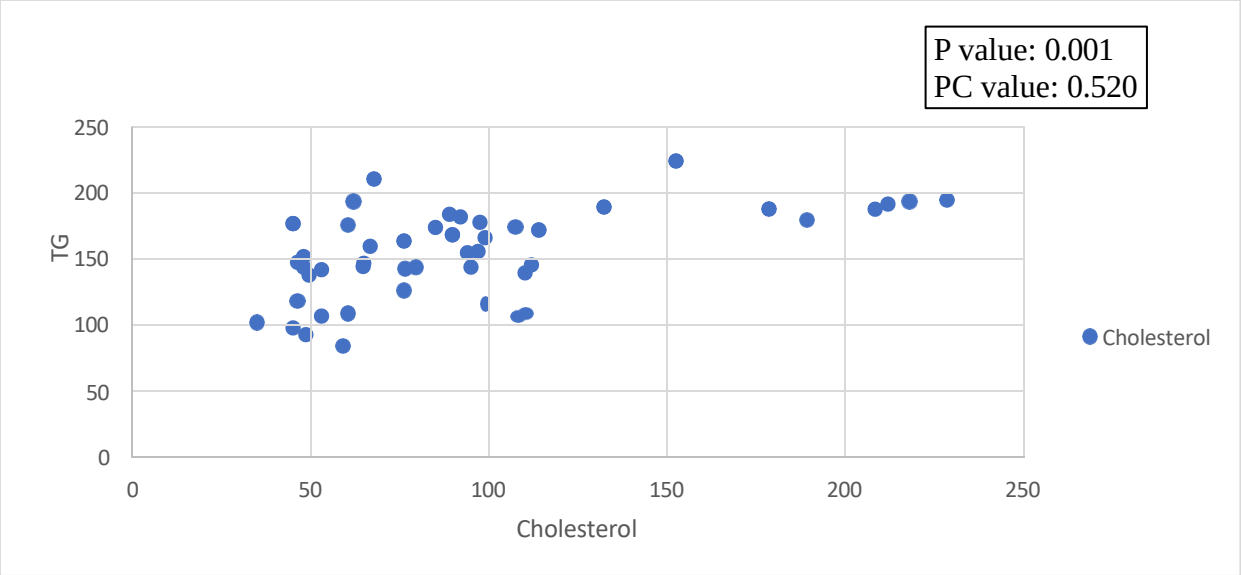

Figure 4.5: shows the correlation between triglyceride and cholesterol.

4.12. Correlation between LDL and Cholesterol

Figure (4.6) Shows the correlation between LDL and Cholesterol. The Statistical analysis showed that there is no significant correlation between them P value: (0.001), with a positive Pearson correlation coefficient of (0.830).

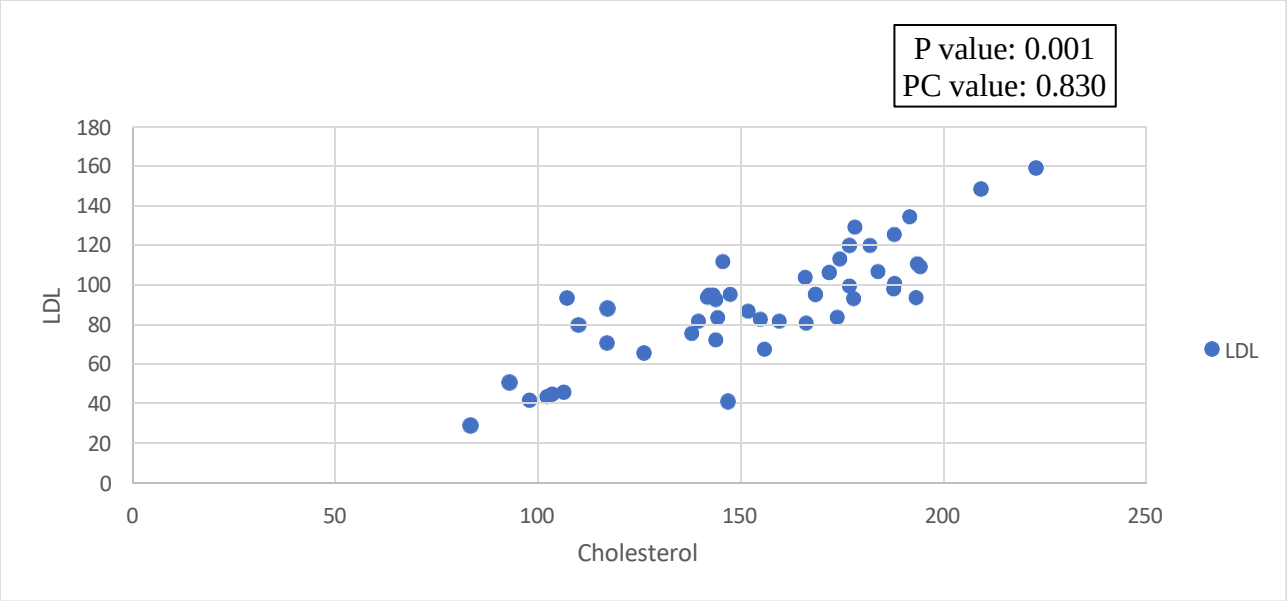

Figure 4.6: shows the correlation between Low density lipoprotein (LDL) and cholesterol.

CHAPTER FIVE

5.0. Discussion

Energy drink consumption has been non-significant by our research for TC levels (P value: 0.469) but according to previous researches such as (Shah et al.,2019) found that participants consuming energy drinks daily for 4 weeks showed a significant increase in total cholesterol by 7.8%. And a study by (Ebuehi et al.,2011) demonstrated that rats given energy drinks for 30 days exhibited elevated serum total cholesterol levels compared to control.

Energy drinks have shown non-significant by this research LDL cholesterol levels (P value: 0.185) however researches by (Worthley et al., 2010) found that consumption of a single energy drink increased LDL oxidation, and a study by (Garcia et al.,2017) demonstrated that regular energy drink intake over 3 months led to a 15% increase in LDL levels (Worthley et al., 2010) (Garcia et al., 2017).

For (TG) the current case-control study showed non-significant effects (P value: 0.304). but research by (Busuttil et al.,2016) showed a 26% increase in (TG) levels after regular energy drink consumption for 6 weeks. (Busuttil et al., 2016) (Basrai et al., 2019).

The current case control study showed non-significant effect for HDL (P value: 0.304) but studies show different results regarding energy drinks' impact on HDL levels, research by (Nowak et al.,2018) found a decrease in HDL levels after regular energy drink consumption, however some studies like (Alsunni et al.,2011) found no significant changes in HDL levels (Nowak et al., 2018) (Alsunni & Badar, 2011).

The current case control study also showed non-significant effect on BMI (P value: 0.395) as we compared with other studies like a study by (Sadowska, J. et al.,2012): as compared to baseline values after one month of “fearless energy drink” consumption, BMI (21.41±1.93 vs. 21.7±12.02; (P value: 0.001). (Famurewa et al., 2015).

The current case control study was done on individuals who drink energy drinks. Based on our study energy drinks was statistically highly significant effect on the mental health (P value: 0.001), and we compared with this study was conducted by (Richards, G, et. al.,2016): the majority of studies examined reported positive associations between energy drink consumption and symptoms of mental health problems, Though the findings imply that energy drink use may increase the risk of undesirable mental health outcomes, the majority of research examined utilized cross-sectional designs. (Richards & Smith, 2016).

The present case-control study found that energy drink consumption had a non-significant effect on blood pressure (p value: 0.573). In contrast, a previous study by (Nowak, D., et al.,2018) reported that energy drink consumption contributed to an increase in diastolic blood pressure (p-value: 0.003).

This study showed that consumption of energy drink had a significant positive and negative effect on sleep cycle (P value: 0.001) and was the reason for poor sleep quality. As in a previous study conducted by (Lohsoonthorn, V., et al.,2013) finds the extent to which poor sleep quality is associated with consumption of energy drinks (P value: 0.002).

The ongoing case control study showed that consumption of energy drink had a significant effect on appetite changes (P value: 0.001), some individuals got boosted appetite and some were suppressed. A research conducted by (Haller, c., et al.,2018) showed the suppression of appetite by caffeinated drinks. Caffeine is often recognized for its potential to suppress appetite temporarily this study found that high doses of caffeine significantly decreased food intake. (Beaudoin et al., 2017) (Smit & Rogers, 2000), (Haller et al., 2018).

As well as several studies that found non-significant associations between energy drink consumption and metabolic syndrome such as:

(Coslovky et al., 2019). A cross-sectional study examining college students found no significant association between moderate energy drink consumption and metabolic syndrome markers when controlling for other lifestyle factors

(Al-Shaar et al., 2017) conducted a small randomized controlled trial that found no significant acute effects of a single energy drink on insulin sensitivity or glucose tolerance in healthy adults without pre-existing metabolic conditions.

In their systematic review, (Mathews and Peterson., 2020) reported inconsistent evidence for energy drinks and metabolic health, noting that when controlling for overall diet quality and physical activity, the independent effect of moderate energy drink consumption on metabolic syndrome risk factors was not statistically significant.

When adjusted for total sugar intake, (Harrington et al., 2016) found that energy drinks did not show a significant independent association with metabolic syndrome markers, suggesting the effect may be primarily related to overall sugar consumption rather than other energy drink components. 6. In a twin study controlling for genetic factors, (Willson and Kapoor., 2021) found no significant relationship between moderate energy drink consumption and metabolic syndrome risk when twin pairs with discordant consumption patterns were compared.

Conclusion

This case-control study examined the effects of energy drink consumption on metabolic parameters. The findings revealed both significant and non-significant associations between energy drink consumption and metabolic syndrome components. While some results aligned with previous research in this domain, others diverged from established patterns. Notably, the study identified a significant relationship between energy drink consumption and sleep cycle disruption, which carries important implications given the known association between poor sleep quality. This research contributes valuable insights to the growing body of evidence regarding energy drink consumption. The findings underscore the absence of proven health benefits from energy drinks, while highlighting potential risks associated with their consumption. Many components in these beverages lack thorough research and regulatory oversight, raising concerns about their safety profile, these results emphasize the importance of cautioning patients about energy drink consumption, especially during pregnancy and breastfeeding periods. Furthermore, healthcare workers themselves should be mindful that consumption of substances affecting behavior, including energy drinks, may potentially compromise the quality of patient care. finally, this study provides important evidence that can inform public health policies and regulations regarding the sale and marketing of energy drinks, particularly to younger populations who represent a significant portion of the consumer base.

Recommendation

1. Energy drinks offer no established health benefits and contain many ingredients that lack thorough scientific investigation and regulatory supervision.
2. Energy drinks are not recommended as an option for individuals in need of an energy boost, as their components may lead to potential risks to health.
3. The known and unknown chemical interactions of these beverages, coupled with documented adverse reactions, indicate potential for serious negative effects.
4. Primary impacts target the nervous system, including heightened alertness, sleep pattern disturbances, cardiac arrhythmias, and seizures in rare instances.
5. Medical providers should educate and warn patients about the risks of energy drink consumption during pregnancy and lactation.

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پوختە:

کورتەی بابەت: پیشەسازی خواردنەوە وزە بەخشەکان لەم ساڵانەی دواییدا گەشەیەکی بەرچاوی بەخۆیەوە بینیوە، لەگەڵ ئەوەشدا چەندین برِاند لەسەر ئاستی جیهان بەردەستە و بەکارهێنانی ئەم خواردنەوانە لە ساڵی ٢٠١١ گەیشتە ٤.٨ ملیار لیتر. ئەم خواردنەوانە بەهۆی دابینکردنی وزەیەکی زیاتر پاڵنەرێکە بۆ زیاتر بە ئاگابوون و زیادکردنی تەرکیز و هێز، وە باشترکردنی چالاکی وەرزشیەکان. خواردنەوە وزەبەخشەکان پێکهاتەیەکی شلە کە بەزۆری کافایین لەخۆدەگرێت، وە هەندێک جار لەگەڵ پێکهاتەی خۆراکی تری زیادکراو. لێکۆڵینەوەکانی پێشوو ئەوەیان دەرخستووە کە بەکارهێنانی بەردەوامی ئەم خواردنەوانە پەیوەندی بە چەندین کێشەی تەندروستی و رەفتارییەوە هەیە، وەک نەخۆشی کۆ نیشانەکانی مێتابۆلیک کە تایبەتمەندییەکانی بریتین لە بوونی چەندین هۆکاری مەترسی و سەرەکی نەخۆشییەکانی دڵ و خوێنبەرەکان، لەوانەش بەرزبوونی پەستانی خوێن، بەرزبوونی ئاستی شەکری خوێن، زیادبوونی (پێوەرەکانی بارستەی جەستە)، و کۆلێسترۆڵ و کەمبوونی چەوری خوێنی چڕی بەرز (چەوری باش) یان زیادبوونی چەوری سیانی.

شێوازی توێژینەوەکە (مێتۆد): ئەم توێژینەوەمان لە جۆری لێکۆڵینەوەی (کەیس-کۆنترۆڵ) بوو، کاریگەرییەکانی بەکارهێنانی خواردنەوە وزە بەخشەکان لەسەر چەندین دەرخەری مێتابۆلیکی و کێشە فیزیۆلۆژییەکانی تر کە لە نێوان ٥٠ بەشداربوو ئەنجامدرا، وە دابەشکرابوون بەسەر دوو گرووپدا: ٣٠ کەس وەك کەیس و ٢٠ کەسی وەك کۆنترۆڵ، کە تەمەنیان لە نێوان ١٨-٣٤ ساڵ بوو. هەموو توێژینەوەکەمان لە ماوەی پێنج مانگدا تەواو کرد. دەرخەرەکان دابەشکرابوون بەسەر پشکنینەکانی چەوری، پەستانی خوێن، شەکری خوێنی بەرۆژوو، (پێوەرەکانی بارستەی جەستە)، و چەند کاریگەرییەکی تر کە لە شێوەی پرسیار دانرابوون کە ئەوانیش، بۆ سوڕی خەو، گۆڕان لە هەڵسوکەوت، و گۆڕانی ئارەزووی خواردن بوون.

ئەنجامەکان: ئەنجامەکانی توێژینەوەکە ئەوە بوون کە خواردنەوە وزە بەخشەکان کاریگەری نیە لەسەر زیاد بوونی چەوری خراپ و کەم بوونی چەوری باش و شەکری خوێن و پەستانی خوێن، هەرچەندە ئە نجامەکانی لەلایەن توێژینەوەی دیکە پشت ڕاست کراوەونەتەوە، وە ئەنجامەکانی توێژینەوەکە نیشاندەرن لەسەر کاریگەری لەسەر گۆڕانی خەو و هەڵس و کەوت و نەمانی ئارەزووی خواردن، وە هەموو ئەمانەش بە داتا لەم توێژینەوە باس کراوە.

دەرئەنجامکان: ئەم لێکۆڵینەوەیە چەندین دەرخستە و نیشاندەری گرنگ و نا گرنگی دەربارەی کۆ نیشانەکانی مێتابۆلیک و لایەنە فیزیۆلۆژییەکان و رەفتارییەکانی بەکارهێنانی خواردنەوە وزەبەخشەکان دەرخستووە. ئەنجامەکانی ئەم توێژینەوە لەلایەن توێژینەوەکانی تردە پشتڕاست کرانەوەتەوە، وەک ئەنجامەکانی سوڕی خەو، گۆڕانی هەڵسوکەوت و ئارەزووی خواردن، پشکنیەکانی چەوری، هەروەها هەندێک ئەنجامی پشکنیەکانی چەوری هاوشێوە نەبوون.

خلاصة:

الخلفية: حصلت صناعة مشروبات الطاقة نموًا كبيرًا خلال السنوات الأخيرة، مع توفر العديد من العلامات التجارية عالميًا وبلغ استهلاكها ٤.٨ مليار لتر في عام ٢٠١١. تشتهر هذه المشروبات بتوفير دفعة إضافية من الطاقة، وتعزيز اليقظة، وتعزيز الانتباه، والحفاظ على اليقظة، تحسين الأداء الرياضي. مشروبات الطاقة هي منتجات سائلة تحتوي عمومًا على الكافيين، وأحيانًا يتم دمجها مع المكملات الغذائية المكملات الغذائية. وتوصلت دراسات سابقة إلى أن الاستهلاك المنتظم لهذه المشروبات يرتبط بمجموعة متنوعة من المشكلات الصحية والسلوكية. مثل التمثيل الغذائي متلازمة تتميز بوجود العديد من عوامل الخطر الرئيسية لأمراض القلب والأوعية الدموية، بما في ذلك ارتفاع ضغط الدم ارتفاع مستويات السكر في الدم وزيادة مؤشر كتلة الجسم وخلل شحميات الدم (انخفاض الكوليسترول البروتين الدهني عالي الكثافة أو زيادة الدهون الثلاثية).

المنهجية فى الدراسه: بحثت دراسة الحالات والشواهد هذه في تأثير استهلاك مشروبات الطاقة على معايير أيضية مختلفة ومشاكل فسيولوجية أخرى بين ٥٠ مشاركًا مقسمين إلى مجموعتين ٣٠ حالة ٢٠ ضابطًا تتراوح أعمارهم بين ١٨-٣٤ عامًا. تم إكمال مشروع البحث بأكمله في خمسة أشهر. تم تقسيم المعلمات إلى ملف الدهون، ارتفاع ضغط الدم، وسكر الدم الصائم، ومؤشر كتلة الجسم، واستبيانات دورة النوم، وتقلبات المزاج، وتغيرات الشهية.

النتائج: أظهرت البحث، النتائج أن مشروبات الطاقة لا تؤثر على زيادة الدهون السيئة ونقصان الدهون الجيدة، ولكنها تؤثر على النوم والتغيرات السلوكية وفقدان الشهية، وكل ذلك موصوف في هذه الدراسة.

الاستنتاجات: وصلت البحث عن العديد من النتائج ذات دلالة و غير دال فيما يتعلق بكل من متلازمة التمثيل الغذائي والجوانب الفسيولوجية والسلوكية لاستهلاك مشروبات الطاقة .تم تأكيد نتائج هذا البحث من قبل أبحاث أخرى ، ولكن بعض النتائج كانت غير متطابقة مع مؤشرات متلازمة التمثيل الغذائي.