

UNIVERSITY OF CAPE COAST

ACUTE EFFECT OF ENERGY DRINK CONSUMPTION ON
PHYSIOLOGICAL RESPONSES AND PHYSICAL PERFORMANCE
VARIABLES OF UNIVERSITY ATHLETES

YAYRA KLUBOITO

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BY

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Thesis submitted to the Department of Health Physical Education and
Recreation of the Faculty of Science and Technology Education, College of
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requirements for the award of Master of
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DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature Date

Name: Yayra Kluboito

Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor's Signature Date

Name: Dr Monday Omoniyi Moses

Co-Supervisor's Signature Date

Name: Dr Charles Domfeh

ABSTRACT

Current research has shown varied results when comparing the effects of energy drink on anaerobic exercise measures. Athletes in Ghana have been using energy drink over the time but hardly has any research been conducted on the effect this pre exercise consumption has on their physical performance. The purpose of this study was to find out the short term effects of energy drink on some blood pressure, heart rate, agility, lower body strength and upper body strength of athletes of the University of Cape Coast. To ascertain this, participants were taken through agility, overhead medicine ball throw and vertical jump tests in a pre-test and a post-test. The intervention in this study was the consumption of 250ml of Red Bull energy drink. Forty-four trained athletes (Age: 22.32 ± 2.81 years, height: 167.2 ± 9.83 cm, weight: 61.12 ± 8.01 kg). Paired sample t-test results showed no significant effect of energy drink consumption on systolic blood pressure ($t = -0.78, p = 0.437$), diastolic blood pressure ($t = -0.91, p = 0.366$), heart rate ($t = -0.30, p = 0.759$) and lower body strength ($t = 0.11, p = 0.916$). However, there were significant changes in agility ($t = 5.42, p = 0.001$) and upper body strength ($t = -2.79, p = 0.008$). Independent sample t-test showed no effect difference on agility ($t = -1.13, p = 0.264$) and upper body strength ($t = -1.77, p = 0.085$) between male and female participants. In view of this, athletes, trainers, and coaches could consider recommending the use of energy drink as a pre-exercise supplement, especially in events involving agility and upper body strength.

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DEDICATION

To my Family

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CHAPTER ONE

INTRODUCTION

Background to the Study

Sports requires that participants should possess an expected high level of physical and physiological fitness. This could be attributed to the fact that the demands of sports rely heavily on both the anaerobic and aerobic energy sources (Michael, Rooney & Smith, 2008). Although different kinds of sports require different kinds of skills and fitness variables (Marchetti et al., 2015), the ability to perform effectively and efficiently as well as show skill mastery competence cuts across all sports disciplines (Gaurav, Singh & Singh, 2011). Athletes therefore require good skill training, physical and physiological conditioning as well as psychological profile (Wang et al., 2013).

Some athletes, however, instead of adhering to proper training and conditioning after practicing and aspiring to perfect their skills, resort to other means which include caffeine and energy drink consumption (Alsunni, 2011). To perform well in their exercise regimens, most athletes cultivate the habit of consuming energy drinks to enhance performance during training. This practice is slowly becoming a part of athletes' exercise regimens. Among the performance enhancers used by athletes is caffeine an ingredient often consumed in the form of energy drinks.

Although the concept of 'energy drinks' has been defined in several concise complex ways, Heckman, Sherry and Gonzalez de Mejia (2010) simply defined energy drinks as beverages that contain besides calories, caffeine in combination with other presumed performance enhancing ingredients such as taurine, herbal extracts and B vitamins. Caffeine, the main

'energy' ingredient in energy drinks is a pharmacologically active substance and despite extensive research, its effects and health consequences still form the subject of ongoing debate (Finnegan, 2003, Committee on Nutrition and the Council of Sports Medicine and Fitness, 2011, Sengpiel et al, 2013). When caffeine is absorbed in the body, it stimulates the sympathetic nervous system and results in a rise in plasma catecholamine that allows the body to adapt to the stress created by physical exercise (An, Park, & Kim, 2014).

Paddock (2008) reported that the most widely used medicinal ingredient in energy drinks, apart from caffeine, is the amino acid taurine. The supplementation of the diet with taurine is known to have many cardiovascular benefits (Militante, & Lombardini, 2004). Various physiological functions have been attributed to taurine, among them are osmoregulation, calcium modulation and anti-oxidation. However, much still has to be understood about the role that taurine plays in the maintenance of life and normal function. In spite of this, the taurine in Red Bull has been promoted as the drink's secret and controversial ingredient even though research on the effects of taurine is limited and inconclusive (Aggarwal, Mishra, Crochet, Sirimanna, & Darzi, 2011).

Glucuronolactone is a carbohydrate that occurs naturally in the body and, like taurine, it is suspected to help in detoxifying the body. Paddock (2008) said that substances in energy drinks include glucuronolactone which increases energy and feelings of well-being. An assortment of B vitamins (B2, riboflavin; B3, niacin; B6; and B12) are the final ingredient common to the majority of energy drinks. While the importance of vitamins to healthy living is undeniable, it may be more appropriate to ingest them in the form of a

balanced diet than in the form of an energy drink supplement. Babu, Church and Lewander (2008) opined that inclusion of caffeine containing herbal ingredients such as guarana, kola nut, tea, yerba mate, and cocoa does not necessitate caffeine labelling, and their presence may not be included in calculations of caffeine content. They nonetheless contribute to the overall caffeine content of a beverage. This implies that there is more caffeine in energy drinks than is indicated in the labelling.

The reputed benefits of moderate caffeine consumption include improvements in physical endurance, cognitive function; particularly alertness and vigilance, mood and perception of fatigue (Ruxton, 2008). Alsunni (2011) submitted that despite the functions of energy drinks, there are concerns that the risks of dehydration, anxiety, headache and sleep disturbances increase with excessive intakes of energy drinks. Other effects like caffeine intoxication, withdrawal and dependence have raised issues about the regulations governing energy drink content labelling and health warnings (Reissig, Strain, & Griffiths, 2009). Caffeine typically increases endurance performance; however, efficacy of caffeine ingestion for short-term high-intensity exercise is equivocal, which may be explained by discrepancies in exercise protocols, dosing, and subjects' training status and habitual caffeine intake found across studies (Astorino, & Roberson, 2010).

Basically, when the body is subjected to exercise and its physical demands are increased, the cardiovascular system is forced to work more quickly and more efficiently to fulfil bodily needs inducing a number of physiological changes that occur over time to this system through exercise. One of the important physiological changes experienced by the cardiovascular

system due to exercise is the reduction of blood pressure (BP) which is defined as the force of blood being pushed against the walls of the arteries of the cardiovascular system (American Heart Association, 2010).

Blood pressure has two components; systolic pressure which is measured during a heartbeat, and diastolic pressure, which is present between heartbeats (Sacks et. al., 2001). Blood pressure is measured as the relationship of systolic to diastolic levels. High blood pressure, expressed as a measurement greater than 140/90 mmHg (millimetres of mercury, a unit of atmospheric pressure), is a condition where the heart is forced to work harder than it was designed in order to direct blood through the entire system. According to the American Heart Association (2010), high blood pressure raises the risk for heart attack and stroke. However, subject to other genetic factors or environmental impacts such as smoking, exercise will tend to reduce blood pressure. Athletes almost always possess a blood pressure reading significantly lower than that normally found in the regular population. Consumption of energy drink and usually in high amounts has been shown to elevate the blood pressure at a jump start level. A study by Poliński, Kot and Meresta (2011) reported a high correlation between heart rate (HR) and blood pressure, showing their interdependence. Thus, improving HR helps in improving the BP.

Heart rate is the number of times per minute the heart beats. During the warm up before one begins to exercise, the heart rate tends to rise in order to prepare for physical activity, supplying the muscles in the body with more oxygen to create energy (Choi, & Guteirrez-Osuna, 2009). The resting heart

rate is normally around 72 beats per minute; however, athletes and people who are cardio fit will have a lower resting heart rate (Almeida, & Araujo, 2003).

The working heart rate is the heart rate during exercise and this varies depending on a person's level of fitness. Almeida and Araujo (2003) again said that an untrained person's heart rate will rise much quicker than that of a trained person and will continue to rise as exercise duration and intensity increases. While the unfit person's heart rate rapidly increases, a fit person's heart rate will slowly increase until it reaches a steady state, where the heart rate remains for the period of exercise at the level of intensity. The recovery of heart rate will be much quicker for a trained person than an untrained person.

These physiological changes occur as a result of different physical activities involved in sports performance. This is also true for which of the energy systems is called to play during performance. The aerobic energy system works with oxygen. Theoretically, the more oxygen a person can use during high level exercise, the more energy a person can produce (Bassett, & Howley, 2000). Therefore, oxygen consumption is very important to this energy system. The oxygen taken into the body at the level of the lungs is ultimately used for the production of Adenosine Tri-phosphate (ATP) in the mitochondria of body cells. Because most of the energy in the body is produced aerobically, maximum oxygen consumption, ($VO_2\text{max}$), which is the amount of oxygen taken up and utilized by the body, can be used to determine how much energy the body is expending. Oxygen consumption is dependent on the ability of the heart to pump out blood, the ability of the tissues to extract oxygen from the blood, the ability to ventilate and the ability of the

alveoli to extract oxygen from the air (Seiler, Joranson, Olesan, & Hetlelid, 2013).

Speed, agility, jumping, throwing and hitting are explosive activities and can be attributed to the anaerobic energy system. The anaerobic energy system comprises non-aerobic breakdown of carbohydrate (Gastin, 2001). The capacity of the anaerobic system is, however, limited by the amount of energy that can be released in a single exercise bout. Muscle strength refers to the amount of force a muscle can produce with a single maximal effort. Size of muscle cells and the ability of nerves to activate them are related to muscle strength (Palao, & Valdés, 2013). For athletes, muscle strength plays a very important role in their performance. The more strength an athlete has, the better it is for his or her performance.

Agility is a rapid whole body movement with change of velocity or direction in response to a stimulus. Agility has relationships with trainable physical qualities such as strength, power and technique, as well as cognitive components such as visual scanning techniques, visual scanning speed and anticipation (Sheppard, & Young, 2006). Reaction time is duration between applications of a stimulus to onset of response (Bhabhor, et al., 2013). These two variables, agility and reaction time go together in sports performance as a quick response to stimuli will reap good agility test results.

Various researches have been done on different variables to either prove or disprove the ergogenic capability of energy drinks. Carvajal-Sancho and Moncada-Jimenez in 2005 investigating the acute effects of an energy drink on the Physical and Cognitive performance of male athletes found no significant changes in the physical and cognitive variables when comparing

energy drink, a placebo and control conditions. However, significant pre to post-test improvements in strength and power were found regardless of the experimental condition. Contrary to this finding, Alsunni (2011) stated that caffeine has an effective ergogenic agent by delaying fatigue and increasing time to exhaustion during endurance exercise but its efficacy as an ergogenic aid during anaerobic exercise and strength and power events is limited.

A randomized double blind placebo-controlled research conducted by Stojanovic, et al. (2011) which investigated the effects of pre-exercise high energy drink on exercise performance in physically active men and women showed significant improvement in aerobic performance but no significant improvement in anaerobic performance. These participants were healthy recreationally active persons and their exercise frequency differences might have contributed to their performance in the variables tested in the research. Again, all the participants might not have been well trained in the performance variables measured (strength, agility, power and cardiovascular endurance). Stojanovic et al. (2011) concluded that, based on the results of their study they support the use of high energy drink before exercise to improve endurance performance while Carvajal-Sancho (2005) did not support the beneficial acute effect of an energy drink in physical and cognitive variables in male athletes.

In another study to determine the effects of Red Bull Energy on repeated Wingate cycle performance and elbow flexor muscle endurance, caffeine (2mg/kg body mass) ingested through Red Bull Energy Drink had no ergogenic effect on maximal isokinetic elbow flexion exercise or repeated peak and mean power Wingate anaerobic cycle tests (Lufkin, 2011). In this

study, 18 resistance trained male participants between the ages of 18-35 years ingested either Red Bull or placebo 60 minutes prior to exercise testing. Other researches have been conducted on some anaerobic activities of which strength is a part of. Dawes, Campbell, Ocker, Temple, Carter and Brooks (2014) conducted a research to find the effects of a pre-workout energy drink on measures of physical performance and in this study, they investigated the effect of four ounces of energy drink beverage on vertical jump as a test for anaerobic power. The energy drink treatment was found not to have any effect on the vertical jump of the participants of this study. Other studies have tested the effect of one energy drink or the other on strength variables. Hawley (2012) investigated the effect of an energy drink on acute muscle strength in young males and found no significant difference in peak torque. Also a dose response effect of caffeine-containing energy drink on muscle performance investigation showed no significant changes in maximal power during maximal power in half squats and bench press after the consumption of 1mg/kg of the energy drink (Del Coso, Salinero, González-Millán, Abián-Vicén, & Pérez-González, 2012). Again contrary to these results, significant changes were found in peak velocity (McCann et al., 2012), bench press maximum (Goldstein, Jacobs, Whitehurst, Penhollow, & Antonio, 2010) and peak force, peak power and peak velocity (Krammerer et al., 2012).

The researchers cited above came up with different results and therefore drew different conclusions about the effect of energy drink on anaerobic physical activity variables. This means that there is inconclusiveness in the available information on the effects of energy drink on anaerobic physical activity variables.

Statement of the Problem

Athletes and physically active persons take energy drinks either to boost the energy expenditure or to replace lost energy. There is a rising curiosity of individuals on the effect of energy drinks on physical performance especially in a country like Ghana as television commercials make consumption look really appealing to the general public and athletes. Advertising for these products typically features images conjuring great muscle power and endurance. As a result of this phenomenon, there has been the need to investigate into this area in the country. Empirical research on energy drink consumption and the effects amongst Ghanaian populations has been scanty. However, the habit of consuming energy drink to enhance performance appears to be slowly becoming a part of the exercise regimens of most physically active person.

In a research conducted on Ghana University Student athletes by Buxton and Hagan (2012), most of the participants (62.2%) reported consuming at least one can of energy drink in a week. The respondents who drank energy drinks indicated that they did so to replenish lost energy after training or a competition, to provide energy and fluids to the body, to improve performance and to reduce fatigue. Again, Nti, Pecku and Opare-Obisiw (2014), reported that 91.0% of university students use energy drinks to help them study and also reduce fatigue. Even though 21.0% of these participants were aware of and had experienced side effects including stomach pains, headaches, and increased heart beats, they still continue to consume energy drinks neglecting future side effects such as chronic diseases (Seifert, Schaechter, Hershorin, & Lipshultz, 2011). Babu, Church and Lewander

(2008) reported that energy drinks are often mistaken for sports drinks, whose primary purpose is rehydration in the event of exercise or fluid loss.

Experiments conducted on the effects of energy drink on physical performance have been in the laboratory setting under very controlled conditions. Meanwhile, athletes and other physically active persons who consume these energy drinks however work in the real world setting. This has brought about the need to conduct an experiment on the field to examine these effects under conditions that are as close as possible to the real world setting amongst a section of Ghanaian population which has come to accept the practice of consuming energy drinks with the aim of gaining extra energy for performance.

Purpose of the Study

The purpose of this study was to examine the acute effect of energy drink consumption on physiological variables (blood pressure and heart rate) and physical performance variables (agility, upper body and lower body strength).

Hypotheses

The study tested the following hypotheses:

1. Short term consumption of energy drink has no significant effect on systolic blood pressure.
2. Short term consumption of energy drink has no significant effect on diastolic blood pressure.
3. Short term consumption of energy drink has no significant effect on heart rate.

4. Short term consumption of energy drink has no significant effect on agility.
5. Short term consumption of energy drink has no significant effect on upper body strength.
6. Short term consumption of energy drink has no significant effect on lower body strength.
7. There is no significant difference in the effect of short-term energy drink consumption on performance variables between male and female athletes.

Significance of the Study

The findings of this study would provide added information on the effects of energy drink on anaerobic physical performances of athletes in Ghana. Results from this study will also help coaches in Ghana advice their athletes on the consumption of energy drinks.

It is imperative that the effects of energy drinks are known because these beverages are so widely used among young athletes especially at the university level where athletes are more independent and have more control over their diet and nutrition than their handlers, and can afford to buy and consume these beverages on their own. Such information may greatly benefit young athletes who compete at intense levels for both a short and a prolonged period of time. In addition, it would provide parents, athletes and coaches with much needed information about the use of these beverages to inform their choices on whether or not they should encourage their wards or athletes to consume such beverages. Also to every physically active person, this would

provide them with good information in addition to information that already exists about consumption of energy drinks and physical activity.

The study would also be a source of reference for students and professionals in the field of physical education and sports. It would also contribute to the advancement of knowledge in the field of sports science in particular and physical education in general.

Delimitations

The study was delimited to the following:

1. One group pre-test and post-test research design.
2. Athletes of the University of Cape Coast who are members of university sports teams and have participated in at least one inter university competition.
3. Independent variables of physiological responses (systolic blood pressure, diastolic blood pressure and heart rate) measured with a sphygmomanometer and physical performance variables (agility, upper body strength and lower body strength) measured using the Illinois agility test, overhead medicine ball throw and the vertical jump test respectively.

Limitations

1. Testing the participants two or three times would have been ideal but it was difficult to get the students to perform the activities repeatedly.
2. Dietary behaviour of the participants before the experiment could have influenced the effect of the energy drink on the athletes.
3. Findings cannot be generalized to other populations.

4. Findings could be as a result of participants becoming familiar with performance tests since they could have been motivated from their first trial to do better in the second.
5. Weakness in the research design. This design has minimal internal validity, controlling only for selection of subject and experimental mortality. It has no external validity.

Definition of Terms

A University athlete: an athlete who is a student of a University, a member of a university sports team and has participated in at least one inter university competition.

Agility: the ability to move quickly and change directions while maintaining control and balance (Sheppard & Young, 2006).

Diastolic blood pressure: the blood pressure when the heart is relaxing (White, 2002).

Energy Drink: a beverage that contains besides calories, caffeine in combination with other presumed energy enhancing ingredients such as trine, herbal extracts and B-vitamins (Heckman, Sherry & Gonzalez de Mejia, 2010).

Heart rate: the number of times the heart beats in one minute.

Illinois agility test: a standardized test that is used to measure agility.

Lower body power: the ability of the body (legs) to combine strength and speed into performance (Palao & Valdés, 2013).

Overhead medicine ball throw: a standardized test used to measure upper body strength.

Short term used in this report refers to the intake of energy drink 60 minutes before performance testing.

Sphygmomanometer: a device used to measure blood pressure.

Stadiometer: a device that is used to measure height.

Systolic blood pressure: the blood pressure when the heart is contracting (White, 2002).

Upper body power: the ability of the arms to translate strength and speed into work (Palao, & Valdés, 2013).

Vertical jump test: a standardized test used to measure lower body strength.

Organization of the Study

Chapter one deals with the issues that went into the choice of the topic of study and its importance as well as the short comings. Review of related literature is in chapter two. Chapter three is organized under methodology; research design, population, sample and sampling procedures, instrumentation, data collection procedures and data analysis. Chapter four dealt with results and discussions while chapter five looked at summary, conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

The purpose of this study were to examine the acute effect of energy drink consumption on systolic and diastolic blood pressure and heart rate and to determine if energy drink consumption improves agility, upper body and lower body strength. The literature review was based on current research and has been aimed at providing a base for the need for this study.

History of Energy Drink in Sports Performance

Energy drinks became popular in Asia long before they reached the United States (González, Miranda-Massari, Gómez, Ricart, & Rodriguez-Pagán, 2012). To ascertain this, González et al. further said that in 1962, the Japanese pharmaceutical company, Taisho, released its Lipovitan D drink, designed to help employees to work hard well into the night hours. An Austrian businessman, Dietrich Mateschitz picked up on the business potential of energy drinks while on a trip to Asia. Then, along with two Thai business partners, Mateschitz started the company Red Bull GmbH, with the idea of marketing the drink to young Europeans. With time, the energy drinks craze started in 1997 when Red Bull was first released in the United States (Higgins, Tuttle, & Higgins, 2010), and it was followed by many others trade names including (Bhasin, 2012). Energy drinks gradually became more than just drinks as the young population consumed them to indicate they have an athletic and modern lifestyle (Bawazeer, & Alsobahi, 2013). Although there are many different varieties in countries throughout the world, Red Bull was the first to be introduced in the United States and still remains one of the most popular choices (Pangarkar, & Agarwal, 2013). Most energy drinks, especially

the initial ones, are non-alcoholic and offer a combination of energy and vitamins, primarily B vitamins (Campbell et al., 2013). These drinks were first accepted mostly by athletes in the United States who would use the drinks to give them extra energy before and during workouts or competitions and games (Heckman et al., 2010). However, as word spread about the effects of energy drinks, the general public entered into the energy drink craze, as well.

Energy drink brands in recent times are experiencing rapid growth and increasing in popularity: they are currently thought to be the next high-growth sector of the soft drink industry as more and more companies take advantage of the 'lucrative' market (Mwaawaru, 2009). As people continue to seek new and better ways of achieving any kind of "high," many people have started mixing these energy drinks with alcohol for even more excitement and fun (Peacock, Bruno, & Martin, 2012). In fact, alcohol companies are even getting involved with the energy drink market by producing alcoholic energy drinks (Reissig, Strain, & Griffiths, 2008).

Because energy drinks are still relatively new, despite being nearly 20 years old, new products are continually emerging (Bhasin, 2012). The choices and exact effects of energy drinks are becoming more diverse as more people seek out energy drinks for a myriad of reasons (Reissig, Strain, & Griffiths, 2008; Peacock, Bruno, & Martin, 2012). Now, in addition to the well-known Red Bull, other drinks such as Monster, Rockstar, Rush, Energy Fizz or Hype are becoming popular choices (Bhasin, 2012; Pangarkar, & Agarwal, 2013).

Ingredients of Energy Drink and their Effects on Sports Performance

Several definitions of energy drinks have come up. Heckman et al., (2010) have defined energy drinks as beverages that contain besides calories

and caffeine, a combination of other presumed energy enhancing ingredients such as taurine, herbal extracts and B vitamins. It has also been defined by Gunja and Brown (2012) as beverages that contain varying amounts of caffeine, taurine, guarana, amino acids, vitamins and sugar and are promoted as being beneficial in increasing stamina, and improving physical performance, endurance and concentration. All these ingredients have their individual properties that need to be looked at. Energy drinks typically contain a mixture of the following ingredients which are elaborated on in the following paragraphs.

Caffeine: Caffeine which is said to be the main “energy” ingredient in energy drinks (Finnegan, 2003; Higgins et al., 2010) is a stimulant that acts on the central nervous system to speed up the messages to and from the brain is known to be primary ergogenic ingredient in energy drinks (Frances et al, 2010). It is a pharmacologically active substance and despite extensive research, its effects and health consequences are the subject of ongoing debate (Finnegan, 2003; Committee on Nutrition and the Council of Sports Medicine and Fitness, 2011; Sengpiel et al, 2013). It has also been said to improve reaction time and cognitive performance, especially in times of increased fatigue (Whitehouse, 2010). Research has shown that excess stimulation of the sympathetic nervous system can result in symptoms such as nervousness, tremors, restlessness, insomnia, gastric irritation, acute elevations in blood pressure, tachycardia and palpitations (Committee on Nutrition and the Council of Sports Medicine and Fitness, 2011; Del Coso et al., 2012).

Caffeine is naturally derived from ordinary food items such as tea leaves, cocoa, coffee beans, and chocolate (McLellan, & Bell, 2004) which

has made it that hundreds of dietary supplements and common household drinks which are readily accessible in everyday life contain it (MacDonald, 2013; Seung-pil, Il-ho, & Soo-cheon, 2002). An average cup of coffee contains approximately 100 mg to 150 mg of caffeine, and soft drinks such as Coca-Cola and Pepsi contain approximately 23 mg to 25 mg in an 8-ounce serving. Some soft drinks, such as Mountain Dew, are known for their higher amounts of caffeine, with approximately 54 mg in a 12-ounce serving (Smith, Graffan, & Roger, 2004; Haskell, Kennedy, Wesnes, Milne, & Scoley, 2007). Caffeine also occurs in several other products such as prescription medications, diuretics, and pain relievers (McIlvain et al., 2011; Ruxton, 2008). Caffeine's widespread use and popularity have caused many people to view the substance as an addictive drug (Astorino et al., 2010), thus making caffeine the most inexpensive and readily available drug known to man. Then on the other hand there are people who view caffeine as a helpful stimulant that increases the individual's concentration and awareness as well as many other physical traits (An et al., 2014). The important thing to remember is that caffeine's effects vary based on the person, the amount ingested, the frequency of consumption, and individual metabolism (Campbell et al., 2013).

Below is a table indicating the caffeine content of some popular energy drinks and soft drinks. These include energy drinks and some soft drinks which are not really consumed for their caffeine content.

Table 1- *Caffeine content in popular energy and soft drinks*

Dink	Product Size	Amount of Caffeine Content
Mother Energy Drink	500ml	160mg
Red Bull	250ml	80mg
V Energy Drink	250ml	50mg
Pulse: Vodka, soda & Guarana (alcoholic)	300ml	21mg
Cola Soft Drink	375ml	40-50mg
Diet Cola Soft Drink	375ml	48mg

Australian Drug Foundation (2012)

Guarana: An extract from a plant that contains about twice the amount of caffeine as coffee beans (Scholey & Haskell, 2008). Derived from the seeds of *Paullinia cupana*, a plant native to South American known for its stimulant properties (Higgins et al., 2010), guarana has been shown to contain large amounts of caffeine (4%-8%), theobromine, theophylline, and a high concentration of tannins. Although caffeine concentration may vary widely in guarana preparations, 3 to 5 g of guarana is known to provide approximately 250 mg of caffeine. The effects of guarana ingestion are necessarily similar to caffeine; however, the duration of action may be much no longer with guarana because of the presence of saponins and tannins (Campbell et al., 2013). Inclusion of this ingredient does not necessitate caffeine labelling, and its presence may not be included in calculations of caffeine content it nonetheless contributes to the overall caffeine content of a beverage (Finnegan, 2003).

Taurine: Occurs naturally in food, especially in seafood and meat, and is necessary for normal skeletal muscle functioning. Taurine, a sulphur containing amino acid, is the most abundant intracellular amino acid in humans, and is implicated in numerous biological and physiological functions (Lourenço & Camilo, 2002). The supplementation of the diet with taurine is known to have many cardiovascular benefits. Various physiological functions have been attributed to taurine, among them, osmoregulation, calcium modulation and antioxidation (Militante & Lombardini, 2004). Scientists are still discovering the effects of taurine, but researchers think it helps regulate heartbeat and influence brain chemicals called neurotransmitters (Renee, 2014). However, much still has to be understood about the role that taurine plays in the maintenance of life and normal function.

Glucuronolactone: Is found naturally in the body. It's most likely hepatoprotective, meaning it will reduce ill effect or even improve the physical state and function of the liver, which is where the metabolism of glucose begins enzymatically (Laquale, 2007). By protecting glycogen stores and their synthesis, Glucuronolactone is an ergogenic aid that can help to fuel both exercise performance and recovery. Some of the benefits linked with Glucuronolactone include its effect as an aid to memory retention, concentration and reaction time. It may also promote a positive mood. Glucuronolactone may also be helpful in ridding the body of harmful substances and providing an instant energy boost. Studies show that energy drinks containing glucuronolactone can reduce sleepiness and boost energy, as well as improve alertness and reaction time. Taken with caffeine and taurine, Austrian researchers have also shown that

glucuronolactone has "positive effects upon human mental performance and mood." Approximately 100-200 milligrams of glucuronolactone is needed in order to get an energy boost. With glucuronolactone it's common to notice an increase in clarity of thought, mental focus and physical energy. Glucuronolactone works well when combined with other nutrients, especially caffeine and taurine.

Ginseng: A substance that comes from a variety of plants and is believed to have medicinal properties, but has been found to interact with a number of prescription and herbal drugs. Ginseng has traditionally been used for a number of medical conditions. However, its benefits for most of them haven't been seriously researched. Ginseng is believed to increase energy, have some anti-fatigue properties, relieve stress, and promote memory (Young, 2013). Ginseng has also been studied as a way to improve mood and boost endurance as well as treat cancer, heart disease, fatigue, erectile dysfunction, hepatitis C, high blood pressure, menopausal symptoms, and other conditions. While some of these uses are promising, the evidence isn't conclusive (Renee, 2014). Athletes commonly use red panax ginseng to enhance physical strength and endurance (Young, 2013). Scientific studies show no direct correlation of ginseng consumption to increased athletic ability, but other factors may contribute. Ginseng's stimulant quality enhances the effect of caffeine. Other positive effects of regular ginseng consumption could benefit athletic performance indirectly.

B-group vitamins: Vitamins are essential micronutrients that are required for maintaining normal body functions. There are two types of vitamins: fat soluble and water soluble. Red Bull contains water-soluble

vitamins. Water-soluble vitamins do not get stored as much in the body as fat soluble vitamins. Instead they circulate through the blood plasma, whatever the body does not use will be released. Water soluble vitamins include the group of B vitamins, e.g. niacinamide (vitamin B3), pantothenic acid (vitamin B5), vitamin B6 and vitamin B12, which are contained in Red Bull. These B-group vitamins contribute to normal energy-yielding metabolism, such as the build-up and break-down of carbohydrates and proteins and contribute to normal mental performance (pantothenic acid) and the reduction of tiredness and fatigue (niacin, pantothenic acid, B6, B12). Moreover, B-group vitamins play a central role in the brain; they contribute to the normal functioning of the nervous system.

Sucrose and Glucose: Sucrose and glucose are different types of sugars, which provide energy to body and mind. Sucrose and glucose are different types of sugars which are also contained in the daily diet. The sugar in Red Bull Energy Drink is produced from sugar beet. 100ml of Red Bull Energy Drink equates to 11g of sucrose and glucose combined. This total amount of sugars is comparable to that of 100ml apple or orange juice.

Theobromine: From the cacao plant. It has a similar effect to caffeine and is found in chocolate and many other foods

Theophylline: A drug used for the treatment of respiratory diseases and asthma, marketed under a variety of brand names. It is structurally similar to caffeine. It is also naturally found in tea at very small levels

In a study by Giles et al. (2012), in which they investigated the individual and interactive effects of some ingredients in energy drinks (caffeine, taurine and glucose), it was found that caffeine enhanced executive

control and working memory, and reduced simple and choice reaction time. Taurine increased choice reaction time but reduced reaction time in the working memory tasks. Glucose alone slowed choice reaction time. Glucose in combination with caffeine, enhanced object working memory and in combination with taurine, enhanced orienting attention, from which they concluded that limited glucose effects may reflect low task difficulty relative to subjects' cognitive ability. Caffeine was shown to reduce feelings of fatigue and increased tension and vigour, taurine reversed the effects of caffeine on vigour and caffeine-withdrawal symptoms, and no effects were found for salivary cortisol or heart rate. In their conclusion, they stated, “caffeine, not taurine or glucose, is likely responsible for reported changes in cognitive performance following consumption of energy drinks, especially in caffeine-withdrawn habitual caffeine consumers”. This shows that as much as people consume energy drinks because of the effects of their individual ingredients on their bodies, there is an interaction between these ingredients which should be taken into consideration.

Marketing Strategies of Energy Drink Producing Companies

The energy drink market has long been dominated by Red Bull, with Monster forever lingering in second place (Bhasin, 2012). However, there is another caffeine packed beverage, Rockstar, which is rising to the top tier. Bhasin reported that now in third place after Red Bull and Monster because ‘it’s brand has clearly resonated with customers, partly due to the product itself, and partly due to its image: a sturdy black can with gold and red lettering, gold star icon and provocative slogan (Party like a ROCKSTAR!), not to mention a brand name suggestive of celebrity, high energy and sex

appeal'. As appealing as the branding and slogan of Rockstar are, Red Bull gives you wings and the fact that consumption of Red Bull has been made about a state of mind seems to be more appealing to energy drink consumers (Pangarkar, & Agarwal, 2013) making it the number one energy drink on the market (Bhasin, 2012). The Forbes report by Pangarkar and Agarwal (2013) further attributed the success of Red Bull to their involvement with extreme sports such as hang gliding and bungee jumping and its participation in the formula one circuit through its eponymous team. They further compared the daring nature of these sports to the persona of the founder of Red Bull, Dietrich Mateschitz.

Claytor and Fan (2014) had said in their publication about Monster Beverage Corporation is the United States of America's that it was the largest publicly traded energy drink company by annual revenue. The company was also said to develop, market, sell and distribute energy drinks and alternative beverages. Again, that Monster Corporation utilizes this strategy by directly bringing the products to their customers through public and sporting events, motivating customer demand. The demand was driven by young demographics, its taste, and the post consumption benefits. This technique they also said accelerates the demand for Monster's. It was also reported that the company was ready to introduce other products such as energy shots which also toe the line of energy supplementation.

Monster Beverage Corporation's marketing strategy focuses on their endeavours on cultivating brand awareness and product promotion. Monster Corporation utilizes a push-pull strategy which enhances demand for their products with promotions and advertising. Monster Corporation pushes its

brands with competitions, endorsements from selected public and sporting figures, sampling, sponsorship, advertisements and coupons. It also pulls the consumers' demand by directly bringing the products to their customers through public and sporting events.

What began with the advent of Red Bull in 1984 has evolved into a colossus of different brands claiming anything from sharpened mental acuity to enhanced athletic performance (Yeates, 2010). It has also been reported that Austrian-born Red Bull founder and CEO Dietrich Mateschitz relies on the younger generation for his sales base, exploiting the teenage drive for risk-taking and adventure using dramatic product names, draconian logos, and sponsorship of extreme sporting events. The drink's website declares it increases performance, concentration and reaction speed, improves vigilance, stimulates metabolism, and makes one feel more energetic therefore improving overall well-being (Matinuzzi, Peterson, Iacobone, & Badjou, 2012). Also, the drink is usually marketed to college students and those who participate in extreme sports, but claims to be useful for anyone who wants to be mentally and physically active.

Analysis of results of a conjoint analysis in one research showed that, the most significant factor in consumers' preference and purchasing of energy drinks was packaging, which accounted for 31.78% of consumer choice. The second most significant factor after packaging was price (23.84%). The third most significant factor affecting purchasing decision was caffeine amount (20.59%). The fourth factor affecting consumer decisions was brand (16.39%). The last factor affecting consumer purchasing decisions was the selling point of the product (7.40%) (Koç, Gül, Akpınar, & Yılmaz, 2014). These two

aforementioned leaders of the energy drink market are therefore not wrong with their marketing strategies at all.

In Ghana, the adverts shown on television often give the impression that energy drinks provide one with instant boost of energy to do anything they want to do no matter how physical it is. Some very popular brands in Ghana now include Blue Jeans, Rox energy, Rush energy, Black energy, Burn energy, 5-star energy and many others.

Consumption Patterns of Energy Drink among Students and Athletes

In spite of everything that has been said about energy drinks, consumptions are high among university students who take them for varying reasons. In a survey of energy drink consumption patterns among college students fifty-one percent of participants (n = 253) reported consuming greater than one energy drinks each month in an average month for the semester in which the research was conducted (defined as energy drink user) (Malinauskas, Aeby, Overton, Carpenter-Aeby, & Barber-Heidal, 2007). The majority of users consumed energy drinks for insufficient sleep (67.0%), to increase energy (65.0%), and to drink with alcohol while partying (54.0%). Again, another majority of users consumed one energy drink to treat most situations although using three or more was a common practice to drink with alcohol while partying (49.0%) These were college students attending a state university in the Central Atlantic region of the United States. Among Ghanaian students, a survey to assess knowledge and reasons for consumption of energy drinks indicated that out of 120 students, 77.0% drank 5 to 6 cans of energy drinks per week while 23.0% consumed 7 to 8 cans a week. These users had kept up this habit for up to three years for the reasons of staying up

late to study and also to reduce fatigue (Nti, Pecku, & Opare-Obisaw, 2014). Buxton and Hagan (2012) in a survey conducted among student athletes in Public Universities in Ghana also found that most of the participants (62.2%) reported consuming at least one can of energy drink in a week. A high proportion (53.6%) of the respondents who drank energy drinks indicated that they did so to replenish lost energy after training or a competition. Other reasons given as to why energy drinks were consumed by the study participants included to provide energy and fluids to the body (25.9%), to improve performance (9.8%) and to reduce fatigue (5.4%). These athletes were in competition and if there was no control over their intake of energy drink, could it mean that some of them were actually doping legally?

Cindy Kuzma in the article “Are Olympic Athletes Legally Doping?” in a Men’s health column on January 29, 2014 said that “even though there are concerns about the use of caffeine in Sports, the very key difference between it and other banned drugs is the fact that it is socially accepted”. She also added “evolving science has revealed that performance-enhancing doses of caffeine were practically indistinguishable from everyday use—that’s why the World Anti-Doping Agency (WADA) moved caffeine off the list of prohibited substances”. This they did because of concern about the risk of sanctioning athletes for social or dietary consumption. All the same, misuse is checked (Kuzma, 2014). All these aside, some agencies including the NCAA in the United States of America still have limits on caffeine use even dietary consumption during competition. Fifteen micrograms (15mg) of caffeine per millilitre urine is considered illegal and is counter mount to being a positive test for doping.

There had been a concern that energy drinks were being distributed to athletes by their teams. This in the United States influenced the decision of the National Football League in North America to prohibit teams from distributing energy drinks, although players are allowed to provide their own (Huddleston, & Huddleston, 2012).

A question for contemplation is “has the edge to take energy drinks been influenced by the idea of sports drinks which are high calorie drinks boosting energy and replenishing thirst at the same time? As much as the factors in purchasing decisions such as price, the amount of caffeine and brand, respectively, packaging was the most influential factor affecting the consumers’ choices and preferences for energy drinks, and accounted for 31.78% of purchasing decisions (Koç, Gül, Akpınar, & Yılmaz, 2014). Recent studies on consumption patterns and reasons for consumption have come up with the following results.

In 2013, a research in the UAE by Jacob, Tambawel, Trooshi and Alkhoury, found that 92.0% of the students consumed energy drinks while only 8% took health drinks. Among the energy drink consumers, 95.0% preferred the brand “Red Bull” while only 5.0% preferred “Effect”. Participants who consumed health drinks took it occasionally at least once a day whereas energy drink consumers took at least two cans per day. It was again found that 64.0% of the students started taking health drinks from the age of 3 to 5 years and more than 92.0% of students started taking energy drinks from 15 years of age onwards. It was also observed that 72.0% of the students were influenced by advertisements in television and retail outlay. Around 85.0% of energy drinkers thought that it would enhance their brain

development while 10.0% preferred it due to its taste, 5.0% thought that it would increase their height. The majority of the students (95.0%) were ignorant about the high calorie and caffeine content in these energy drink. Out of the 257 participants in a research conducted by Bawazeer and Alsobahi (2013), it was reported that 27.2% consumed at least one energy drink per month, with 61.5% of which were males. It was therefore reported that males consume significantly more energy drinks than females. The students consumed energy drinks to get energy in general (32.8%) and while studying for exams or finishing a project (31.4%). Other reasons given included, lack of sleep (12.8%), just to be like friends (11.4%), or driving (8.5%). Heart palpitations were the most common side effect in their sample (20.0%), followed by insomnia (10.0%), headache and tremors (5.7%), nausea and vomiting (4.2%) and nervousness (2.8%).

Further, a total of 412 students (282 males and 130 females) responded to questions in a research by Alsunni and Badar, (2011), out of whom 54.6% males and 26.2% female students were energy drink users. In this research, the mean age at first use was significantly less in female students. Inspirations for first time use reported were friends (both genders) and curiosity (males mainly). Most students did not have a fixed frequency of use and the commonest reasons for use were company of friends, to keep awake, for more energy and for better performance in driving, sports or exams. Amongst many the commonest benefit reported was ability to stay awake longer. However, the students reported a number of adverse effects including increased urination and insomnia which were the commonest in males and females respectively. Only 36.7% males and 14.3% females had never experienced an adverse

effect. Among footballers, Badaam and Masroor (2013) conducted a survey and found that about 30.0% football players reported consuming at least one serving of energy drink in a week. Around 37.77% of respondents who consumed energy drinks mentioned that energy drinks helped them to regain energy after training or a tournament. Other reasons given for consuming energy drinks were replacement of body water (33.33%), to enhance performance (22.22%) and to prevent fatigue (6.66%).

Somewhere in Turkey in a survey on energy drink consumption amongst medical students, there were 204 (52.3%) females and 186 (47.7%) males making a total of 390 who participated in the study. Out of this number, 127 reported to have consumed energy drinks at least once who stated the reasons for consumption as curiosity, to increase cognitive performance and to increase physical performance. They further reported that the curiosity was aimed mostly to the taste of energy drinks. Cognitive performance answers when grouped revealed that these students took energy drinks to keep awake while studying and before examinations. Also answers grouped for physical performance were during any sports activity, to relieve fatigue, all other physical activities including dancing, sexual intercourse, travelling, etc. (Hidiroglu, Tanriover, Unaldi, Sulun, & Karavus, 2013).

General Effects of Energy Drinks

Information and research on the many harmful effects and dangers of energy drinks have been well established. However, information and research into the ergogenic effects of these drinks on sports performance has been inconclusive. One true thing about energy drinks is that they have mixed psychological and well-being effects (Ishak, Ugochukwu, Baggot, Khalili, &

Zaky, 2012). Basically side effects such as insomnia, nervousness (Alsunni, & Badar, 2011), restlessness, irritability, stomach upset (Matinuzzi, Peterson, Iacobone, & Badjou, 2012), muscle tremors (Del Coso, Salinero, González-Millán, Abián-Vicén, & Pérez-González, 2012), and increased blood pressure as well as heart rate have been reported from excessive intake of energy drinks (Bawazeer, & Alsobahi, 2013). Such high dose is set at 500mg a day (Matinuzzi, Peterson, Iacobone, & Badjou, 2012) however, in a study conducted by Salinero et al. (2014), it was reported that the ingestion of an energy drink with 3 mg/kg of caffeine increased the prevalence of side effects and the presence of these side effects was similar between male and female participants. Studies have also been done to examine the associations between frequency of energy drink consumption and problematic alcohol use, alcohol-related consequences, symptoms of alcohol dependence and drinking motives (Skewes, Decou, & Gonzalez, 2013), indicating that consumption of energy drinks could affect a person more than is perceived now and in diverse ways. For instance, it could alter the decision time and the thinking process, creating a state of uncertainty and confusion, reducing fatigue and imprinting an energetic rhythm in tasks solving (Aniței, Schuhfried, & Chraif, 2011).

Energy drinks have been investigated for various reasons some of which are briefly explained in this document. Behavioural changes that have been reported are the areas of cognitive performance, mood and reaction time. A caffeine-containing energy capsule produced clear positive effects upon mood and cognition in individuals after a period of prolonged wakefulness (Childs, & De Wit, 2008). These findings the researchers reported was an indication that caffeinated energy formulations improve subjective well-being

and behavioural performance in the absence of expectancy effects associated with energy drinks and independently of an individual's level of habitual caffeine use. In an investigation into the acute effects of an energy drink on the Physical and Cognitive performance of male athletes no significant changes were found in the physical and cognitive variables when comparing energy drink, a placebo and control conditions (Carvajal-Sancho, & Moncada-Jimenez, 2005). Contrary to this finding, Giles et al. (2012) reported changes in cognitive performance following the consumption of energy drinks. A study into the effects of energy drinks and their effects on short-term memory in college students (Whitehouse, 2010) showed that the functional energy drink did not have a significant effect on short-term memory of the participants.

In the area of education, Richards, Millward, Evans, Rogers and Smith investigated the acute effects of energy drinks on behavioural sanctions in secondary school children and found that children in detention were more likely to habitually consume energy drinks and skip breakfast and so concluded, 'breakfast intervention programs and restricting energy drink consumption may be effective methods for reducing problem behaviour in secondary schools (Richards, Millward, Evans, Rogers, & Smith, 2015). In another study concerning energy drink consumption and its relationship to risky behaviour, risk awareness, and behavioural intention in college students, students classified as energy drink users participated in risky behaviours more often than non-users (Buchanan, 2012). Also, energy drink consumption was found to be highly associated with past use of tobacco and cannabis, non-medicinal use of prescription drugs, binge drinking and sensation –seeking and self-reports of medicinal treatment for injury in a study to examine energy

drink consumption and its association with demographic characteristics, drug use and injury amongst adolescents (Hamilton, Boak, Ilie, & Mann, 2013).

Physiologically, the acute ingestion of caffeine has basically been shown to produce mild psychostimulant effects, which are thought to be the reason for its extensive use in the general population (Del Coso et al., 2012). However, the ingestion of moderate-to-high amounts of this substance could also produce negative effects such as anxiety, headaches, elevated heart rate and blood pressure, increased sweating and urine production or insomnia.

Physiological Responses to Energy Drinks during Physical Activity

‘Caffeine can cause a short but dramatic increase in your blood pressure, even if you don’t have high blood pressure’ a medical doctor Sheldon Sheps (2015) said in his article entitled ‘how does caffeine affect blood pressure?’ he further said that some people who regularly drink caffeinated beverages have a higher average blood pressure than do those who drink none. Some researchers believe that caffeine could block a hormone that helps keep the arteries widened. Others think that caffeine causes the adrenal glands to release more adrenaline, which causes the blood pressure to increase. An et al. (2014) have also said that caffeine when absorbed in the body has been found to stimulate sympathetic nervous system and results in a rise in plasma catecholamine that allows the body to adapt to the stress created by physical exercise. Precisely in the heart, it is known to prompt secretion of norepinephrine and epinephrine to increase the rate and force of the muscle’s contractions. These in turn raise the rate and force of the heart, thereby increasing the blood pressure and make the heart beat faster. In their study in which they measured blood pressure and heart rate before consumption and

after consumption of an energy drink, they found significant differences in pre and posttest measurements. Similarly, a study by Nelson, Biltz and Dengel (2014) revealed significant increase in the resting heart rate of participants after the consumption of Monster energy drink. In this study, athletes consumed monster energy drink standardized to 2mg/kg caffeine after eight hours fasting while in the study by An et al., the two experimental groups consumed 1.25mg/kg and 2.5mg/kg dosage of caffeine respectively. These similar dosages of caffeine intake produced similar results under different measures. Could this mean that it is the difference was really caused by the consumption of the energy drink and that it did not matter the kind of exercise the participants were taken through? Nti, Pecku and Opare-Obisaw (2014) in their study had reported that 75% of the participants had increased heart rates as a result of the consumption of energy drinks. These participants were not athletes nor did they report that they felt this after going through physical activity.

In an independent study by Apatov, Eberwein, Klein and Schroeder (2011), they investigated the physiological effects of 5-hour energy drinks. The participants for this study were regular consumers of energy drinks and data was obtained for blood pressure, heart rate, and heart rhythm for all participants. A paired t-test was then conducted with a 95.0% confidence interval on heart rate, systolic blood pressure, diastolic blood pressure and R-R binning. Blood pressure showed no statistically significant changes in diastolic or systolic blood pressure for any of the conditions. Also, there was no significant changes in heart rate as well as heart rhythm irregularities.

Systolic blood pressure was significantly greater post-exercise, with caffeine ($p < 0.05$) (116.8 ± 5.3 mmHg vs. 112.9 ± 4.9 mmHg) in a study by Goldstein et al. (2010). In another study, a significant difference in the systolic blood pressure recorded (Daniels, Mole, Shaffrath, & Stebbins, 1998). Caffeine caused significant increase in the mean systolic blood pressure (60 minutes' post ingestion) from 116.6 to 128.3 mmHg as compared to placebo conditions. The mean rate increased from 72.9 to 77.3 bpm in test group. No change was observed in control group). Caffeine caused significant increases in systolic blood pressure (SBP) (20 and 40 min post ingestion) and maximal arterial pressure (MAP) (40 min post ingestion) compared with placebo conditions. During dynamic exercise plus caffeine, SBP and MAP were higher than in placebo conditions at 60 min post ingestion. However, the magnitudes of caffeine induced increases in resting and exercise blood pressure were not significantly different from respective control conditions. Furthermore, no statistical interaction was found between the effects of caffeine and exercise on blood pressure. Finally, diastolic blood pressure and heart rate were unaffected by caffeine.

Effects of Energy Drinks on Physical Performance Variables

Moderate caffeine consumption includes improvements in physical endurance, cognitive function; particularly alertness and vigilance, mood and perception of fatigue (Ruxton, 2008). In the following sessions are some elaborate discussions of some researches that have been done into its effect of performance variables including strength and agility.

Strength

Energy drinks have been said to increase performance of some physical performance variables one of which is strength which has been researched into by several authors. Strength in physical activity is basically defined as the extent to which muscles can exert force by contracting against resistance. More precisely, muscular strength is the amount of force one can put out or the amount of weight that one can overcome in one repetition measure (1RM) or a single effort. Some of the tests that have been conducted in researches which investigated muscular strength are handgrip strength test, vertical jump test, isokinetic strength test, push-ups, pull-ups, medicine ball throw, trunk lift, and many others, just to name a few.

With regards to the effects of energy drinks on these strength variables, the following have been done. In a study by Eckerson et al. (2011) into the effects of the effects of sugar-free energy drinks on upper body strength and muscular endurance in males, thirteen physically active men were taken through upper body resistance training while refraining from taking in caffeine and alcohol. Sixty minutes prior to their testing, these participants received an amount of sugar free energy drink with taurine and caffeine or with caffeine only sugar free energy drink or a placebo and then they were tested 1RM bench press and then completed as many reps as possible at 70.0% of their 1RM to assess muscular endurance. The results from this study showed that the sugar free energy drink containing caffeine only and the one containing caffeine and taurine had no effect on 1RM bench press compared to a placebo. The thing about this study was that there were manipulations in the ingredients that are contained in the energy drink. Stojanovic et al. (2011) in their study

into the effects of pre-exercise high energy drink on exercise performance in physically active men and women, similar anaerobic strength variables were tested as in the study by Eckerson et al. participants from this study however consumed Ultimate Nox Pump which is a sugar containing energy drink. These participants were taken through tests which consisted hand grip strength test, counter movement and vertical jump. And similar to the results from the former study, analysis of variance revealed no differences between supplement and placebo group in strength, counter movement and vertical jump. Vertical jump was again tested in a study to find the effects of a pre-workout energy drink on measures of physical performance (Dawes et al., 2014). The participants consumed up to four ounces of energy drink or placebo thirty minutes prior to the testing. And in this study too, there was no effect on the vertical jump of the participants. Del Coso et al. (2012) however found an increment in the mean jump height of participants after the ingestion of energy drink in comparison to the control drink in their study. In this study too, a sugar free energy drink was used.

For this particular research strength was tested using the overhead medicine ball throw for upper body strength and the vertical jump test for lower body strength. Red bull energy drink was used and it was consumed sixty minutes before the exercise performance. Results from this study therefore might be similar or different from the reported studies above even though the study protocols are similar.

Agility

A new definition of agility is proposed: “a rapid whole body movement with change of velocity or direction in response to a stimulus”

(Sheppard & Young, 2006). Agility which deals with the changes in direction and agility has been reported to be influenced by explosive strength, balance, muscular coordination, and flexibility, also with the ability to effectively couple eccentric and concentric actions in ballistic movements (Sahin, 2014). This implies that agility has relationships with trainable physical qualities such as strength, power and technique. Cognitive components such as visual scanning techniques, visual scanning speed and anticipation are also part of agility. Therefore, agility testing is generally confined to tests of physical components such as change of direction speed, or cognitive components such as anticipation and pattern recognition (Sheppard, & Young, 2006). These factors have been elaborated in the following table. The Illinois Agility Test is a challenging 15-20 seconds test that requires the students to run fast, stop quickly, change directions, and move the body from a laying position to a running stride as quickly as possible.

In Del Coso et al.'s (2012) research into the effect of caffeine containing energy drink on simulated soccer performance, they investigated as part of their study the effect of Red Bull energy drink on the number of sprints run by their participants in a simulated soccer performance. These sprints in the game could be related to agility as running pattern in soccer involves change of direction. The mean running speed during the speed test in this study was increased as a result of the consumption of the energy drink as against the placebo given. Contrary to the results of the study by Del Coso et al., energy drink treatment did not have any significant effect on reactive sprint test of participants in a study to investigate the effects of a pre-workout energy drink on measures of physical performance by Dawes et al. (2014).

Similarly, a pre workout consumption of energy drink by participants in another study by Paez, Daniel, Hearon, Bliss, and Fiddler (2014) did not cause any significant change in the time taken to complete the test. Issues about reaction time could also be considered in this discussion of agility test results as the participants had to respond to the stimuli for the start in order to make a good time on the agility test. The effect of energy drink and caffeine consumption has been tested on reaction time and some of the studies showed the following results.

It was reported in a study by Duvnjak-Zaknich, Dawson, Wallman, and Henry (2011), that there is improved interpretation and response to stimuli of an individual after ingesting caffeine. Their study was to investigate the effect of caffeine on reactive agility time when fresh and fatigued. Faster times were recorded for the reactive agility and it was reported that tests were consistently faster after the ingestion of caffeine. Jordan (2012) conducted a similar study but added a new twist to it by trying to find out of reactive agility through the dominant and non-dominant side. He found that caffeine supplementation significantly improved players' reaction times to their non-dominant side. The effects of energy drink and caffeine consumption has hardly been tested using a standardized test. The results from investigations that have tested it in different forms has been inconsistent. The way agility is tested in this study will therefore add to the literature available on the effects of energy drink on agility using a standardized test and also make the research easy to replicate.

Effects of Energy Drinks on Sports Performance

Various researches have been conducted on different variables to either prove or disprove the ergogenic capability of energy drinks. Carvajal-Sancho

and Moncada-Jimenez in 2005 published an investigation into the acute effects of an energy drink on the Physical and Cognitive performance of male athletes in which they found no significant changes in the physical and cognitive variables when comparing energy drink, a placebo and control conditions. However, significant pre to posttest improvements in strength and power were found regardless of the experimental condition. Contrary to this finding, Alsunni (2011) stated that caffeine has an effective ergogenic agent by delaying fatigue and increasing time to exhaustion during endurance exercise but its efficacy as an ergogenic aid during anaerobic exercise and strength and power events is limited.

A randomized double blind placebo-controlled research conducted by Stojanovic, et al. (2011) investigated effects of pre-exercise high energy drink on exercise performance in physically active men and women. Participants were taken through a battery of tests consisting hand grip test (to test strength), counter movement and vertical jump as well as an incremental exhaustion on a motorized treadmill. The results showed significant improvement in aerobic performance but no significant improvement in anaerobic performance. These participants were healthy recreationally active persons and their exercise frequency differences the researchers said might have contributed to their performance in the variables tested in the research. Again, all the participants might not have been well vested (trained) in the performance variables measured (strength, agility, power and cardiovascular endurance). Stojanovic et al. (2001) concluded that, based on the results of their study they support the use of high energy drink before exercise to improve endurance performance

while Carvajal-Sancho (2005) did not support the beneficial acute effect of an energy drink in physical and cognitive variables in male athletes.

In a study to determine the effects of Red Bull Energy on repeated Wingate cycle performance and elbow flexor muscle endurance, caffeine (2mg/kg body mass) ingested through Red Bull Energy Drink had no ergogenic effect on maximal isokinetic elbow flexion exercise or repeated peak and mean power Wingate anaerobic cycle tests (Lufkin, 2011). In this study, 18 resistance trained male participants between the ages of 18-35 years ingested either Red Bull or placebo 60 minutes prior to exercise testing.

In another research to investigate the acute effects of a low-calorie, caffeine-aurine, energy drink (AdvoCareSpark®) on repeated sprint performance and anaerobic power in National Collegiate Athletic Association Division I football players, twenty well-trained Division I football players participated in a double-blind, randomized crossover study in which they received the energy drink or an iso-energetic, isovolumetric, non-caffeinated placebo (Gwacham, 2011). These participants took part in two trials which were separated by 7 days. The Running Based Anaerobic Sprint Test (RAST), consisting of six 35-m sprints with 10 s of rest between each sprint, was used to assess anaerobic power. Sprint times were recorded with an automatic electronic timer. On average, there was no statistically significant difference between the placebo and beverage measurements of fatigue index. Neither were there statistically significant main effects of the beverage treatment on power or sprint time. However, there was a significant interaction effect between caffeine use and the beverage for sprint times, as well as for anaerobic power, indicating a confounding effect. This caffeine-aurine energy

drink did not improve the sprint performance or the anaerobic power of collegiate football players, but researchers concluded that the level of caffeine use by the athletes likely influenced the effect of the drink.

Sixteen recreationally trained performed two exercise trials separated by 7 days in a research in which the purpose was to undertake an independent investigation into the effects of ingesting a carbohydrate-protein-electrolyte (CPE) beverage on repeated submaximal and time-trial cycling performance. Each trial comprised two bouts of 90 minutes' exercise separated by a 2-hour recovery period. Each bout comprised 45 minutes' exercise on a cycle-ergometer at 60% VO₂max (ST), followed immediately by a 45-minute performance test (PT). Participants were randomly assigned an 8% CPE beverage or colour/taste matched placebo (PL) prior to each trial. Participants consumed 100 ml of the assigned beverage every 10 minutes during each ST, and 500 ml at 0 and 60 minutes into recovery. Mean power output, speed and distance covered were assessed throughout both trials. Expired air was sampled at 10 minute intervals throughout ST. Blood glucose and lactate were assessed during ST and recovery. For this study, there were no significant changes with regards to distance covered, power output and speed (Roberts, Tarpey, Kass, & Roberts, 2012).

Del Coso et al., (2012) researched in a randomized order, twelve active participants ingested 1 and 3 mg of caffeine per kg of body weight using a commercially available energy drink (FureW, ProEnergetics) or the same drink without caffeine (placebo; 0 mg/kg) in a study to determine the dose response effects of a caffeine-containing energy drink on muscle performance. After sixty minutes, resting metabolic rate, heart rate and blood pressure were

determined. Then, half-squat and bench-press power production with loads from 10 to 100% of 1 repetition maximum was determined using a rotator encoder. In comparison to the placebo, the ingestion of the caffeinated drink increased mean arterial pressure and heart rate at rest in a dose response manner, though it did not affect resting metabolic rate. While the ingestion of 1 mg/kg of caffeine did not affect maximal power during the power-load tests with respect to the placebo, 3 mg/kg increased maximal power in the half-squat and bench-press actions.

To determine the effects of a caffeine-containing beverage on muscle explosiveness during ballistic bench throws, participants after a day of dietary control and caffeine abstinence, otherwise fasted subjects performed four individual ballistic bench throws under two conditions (Redline®, a placebo), with trials being separated by 48-96 hours. The peak force, peak power, peak velocity, peak displacement, and maximum rate of force development of the Redline® trial were compared to a placebo (PLB). Early results suggested a significant increase in peak performance, peak power and peak velocity and a trend in the data for peak displacement and maximum rate of force development (Kammerer et al., 2012).

Del Coso et al. (2012) in an experiment to determine the effects of caffeine-containing energy drink on simulated soccer performance, used nineteen semi-professional soccer players who ingested 630 to 652 mL of a commercially available energy drink (sugar-free Red Bull®) to provide 3 mg of caffeine per kg of body mass, or a decaffeinated control drink (0 mg/kg). After sixty minutes they performed a 15-s maximal jump test, a repeated sprint test (30 m; 30 s of active recovery) and played a simulated soccer game.

Individual running distance and speed during the game were measured using global positioning satellite (GPS) devices. In comparison to the control drink, the ingestion of the energy drink increased mean jump height in the jump test, mean running speed during the sprint test and total distance covered at a speed higher than 13 km/h during the game. In addition, the energy drink increased the number of sprints during the whole game. Post-exercise urine caffeine concentration was higher after the energy drink than after the control drink.

Summary

Because energy drinks are still relatively new, despite being nearly twenty years old, new products are continually emerging. The choices and exact effects of energy drinks are becoming more diverse as more people seek out energy drinks for a myriad of reasons. Energy drinks are gradually becoming more than just drinks as the young population consumed them to indicate they have an athletic and modern lifestyle. These drinks have been defined as beverages that contain besides calories, caffeine in combination with other presumed energy enhancing ingredients such as taurine, herbal extracts, ginseng, glucuronolactone, guarana and B vitamins. Production companies in order to sell their products use catchy packaging and advertisement. Also endorsements from well-known sports and athletes influences the consumers use and even the choice of drink to use. Consumption amongst the general public, students and athletes have been well investigated into and some of the reasons given for the use of energy drinks include insufficient sleep, to increase energy, to drink with alcohol while partying, to provide fluids to the body, to improve performance, to reduce fatigue among others. One true thing about energy drinks is that they have

mixed psychological and well-being effects. Basically side effects such as insomnia, nervousness, restlessness, irritability, stomach upset, muscle tremors, and increased blood pressure as well as heart rate have been reported from excessive intake of energy drinks. Also, energy drink consumption has been found to be highly associated with past use of tobacco and cannabis, non-medicinal use of prescription drugs, binge drinking and sensation –seeking and self-reports of medicinal treatment for injury in a study to examine energy drink consumption and its association with demographic characteristics, drug use and injury amongst adolescents. Caffeine when absorbed in the body has been found to stimulate sympathetic nervous system and results in a rise in plasma catecholamine that allows the body to adapt to the stress created by physical exercise. Several researches have been conducted on the effects of energy drinks on sports performance and mostly the parameters of performance have either shown improvements or non-improvements following the consumption of amounts of energy drink that are set from as little as 1mg/kg to 6mg/kg of caffeine content. This obviously has created the gap because the results vary and so the issue of energy drinks enhancing physical performance especially high intensity short duration activities and events are inconsistent.

CHAPTER THREE

RESEARCH METHODS

The purpose of this study were to examine the acute effect of energy drink consumption on systolic and diastolic blood pressure and heart rate and to determine if energy drink consumption improves agility, upper body and lower body strength. This chapter therefore describes the population, sample and sampling technique, Instrument for data collection, validity and reliability of the instruments, pilot study, data collection procedure, and procedure for data analysis.

Research Design

The study adopted a one group pre-test – post-test experimental research design. This pre-post intervention design is used to evaluate the benefits of specific interventions (Harris, et al., 2006) and when it is not feasible for the researcher to use random assignment (Gribbons, & Herman, 1997). This study has just one group thus, there was no random assignments of participants to groups. The pre-test served as the ‘control’ period. This research was conducted on the field for the sake of ecological validity since the field provides a setting which is close enough to the real world setting and conditions under which persons consume and use energy drinks for performance enhancement.

Population

The total population for this study comprised of student athletes of the University of Cape Coast. The population was an estimated 250 athletes. These athletes are registered students of the University of Cape Coast who are members of the University sport teams. They represent the university in the

Ghana University Sports Association (GUSA) games. They participate in various disciplines including basketball, volleyball, football, handball, hockey, tennis, badminton, table tennis, track and field events among others. These athletes train for inter-hall competitions and when selected to play for the university, continue to train for the GUSA games. The inter-hall competitions are organised in the first semester of every academic year and the GUSA games (mini GUSA and main GUSA games) are organised every year usually in the second semester of every academic year. This implies that these athletes train for at least two months in every semester of every academic year.

Sampling Procedures

Forty-four apparently healthy male and female student athletes volunteered to participate in this study. Volunteers were used because the study involved the consumption of energy drink which not all the members of the population would agree to take in. A notice was sent round to all athletes in the university and interested persons were asked to volunteer. Athletes who volunteered then met with the researcher once during which the purpose of the study and the experimental protocol were explained to prospective participants. They were allowed to ask questions about the research and their questions were duly answered. Then participants who volunteered were used as the participants for the study. Once they had volunteered, their permission was obtained using an informed consent form which committed them to showing up for the data collection.

The physical characteristics of the participants are reported in the following table.

Table 2- *Physical characteristics of participants*

Variables	Range	Mean	Standard deviation
Age (Years)	18 – 33	22.32	2.81
Height (cm)	131 – 188	167.2	9.83
Weight (kg)	43.4 – 80.4	61.12	8.01

Source: Field data, Kluboito (2016)

Data Collection Instruments

Physical characteristics of height and weight were measured for each participant as demographics using the stadiometer and a weighing scale respectively. Blood pressure and heart rate were measured using a sphygmomanometer (The deluxe auto digital blood pressure monitor) which is a device for measuring blood pressure and heart rate.

To conduct the performance tests for this study, there was the need for the following:

1. A flat non-slip surface for conducting the physical performance variables tests.
2. Marking cones to mark the designated areas for the tests and also to mark the course for the agility test.
3. Stopwatch to keep time taken for the participants to complete the activities that were measured in seconds.
4. Measuring tape to measure distances.
5. Chalk for marking the wall in the vertical jump test
6. A medicine ball (55kg) for testing upper body strength

The performance tests were administered to the participants to ascertain agility, upper body strength and lower body strength. To measure the agility, the Illinois agility test was used, to measure upper body strength, the overhead medicine ball throw was used and the vertical jump test was used to measure the lower body strength. Pre-test and post-test protocols included these three activities to measure agility, upper body strength and lower body strength. Following is the detailed description of the tests used for the study.

1. The Illinois Agility Test by Getchell as stated by Horička, Hianik & Šimonek (2014) was used to test for agility. **Procedure:** The test required the use of a flat non-slip surface, marking cones, stopwatch, measuring tape and timing gates (optional). The length of the course was 10 meters and the width (distance between the start and finish points) was 5 meters. Four cones were used to mark the start, finish and the two turning points. Another four cones were placed down the centre and spaced 3.3 meters apart. Participants stood ready behind the start line. On the 'Go' command the stopwatch was started, and the participant got up as quickly as possible and run around the course in the direction indicated, without knocking the cones over to the finish line, at which the time clock was stopped (Horička, Hianik & Šimonek, 2014). **Scoring:** Time taken to complete the course was then recorded in seconds.

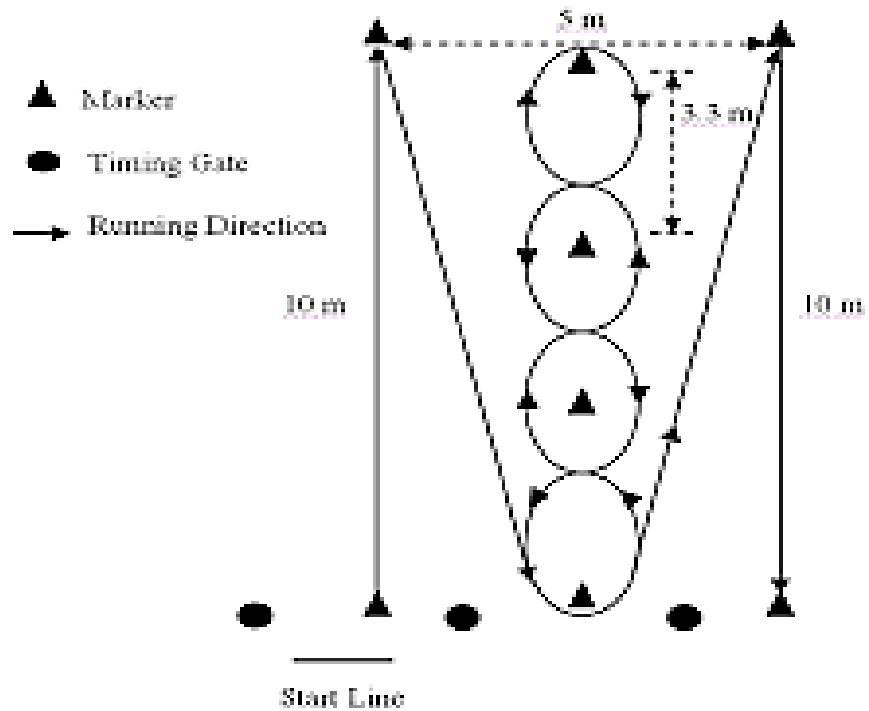


Fig. I- Illinois agility test layout

2. The forward overhead medicine ball throw to measure upper body strength (Reiman, & Mancke, (2009). **Equipment:** Weighted medicine ball, tape measure. **Procedure:** The participants stood at a line with the feet shoulder width apart, facing the direction to which the ball will be thrown. The ball was held with the hands over the head. The throwing action was similar to that used for a soccer side-line throw-in. The ball was brought back behind the head, and then thrown vigorously forward as far as possible. The participants were permitted to step forward over the line after the ball is released (they were in fact encouraged to do so to maximize the distance of the throw) and to give in at the knee. Two attempts were allowed. **Scoring:** The distance from the line to where the ball landed was recorded. The measurement was recorded to the nearest 10 cm. The best result of the two throws was used.

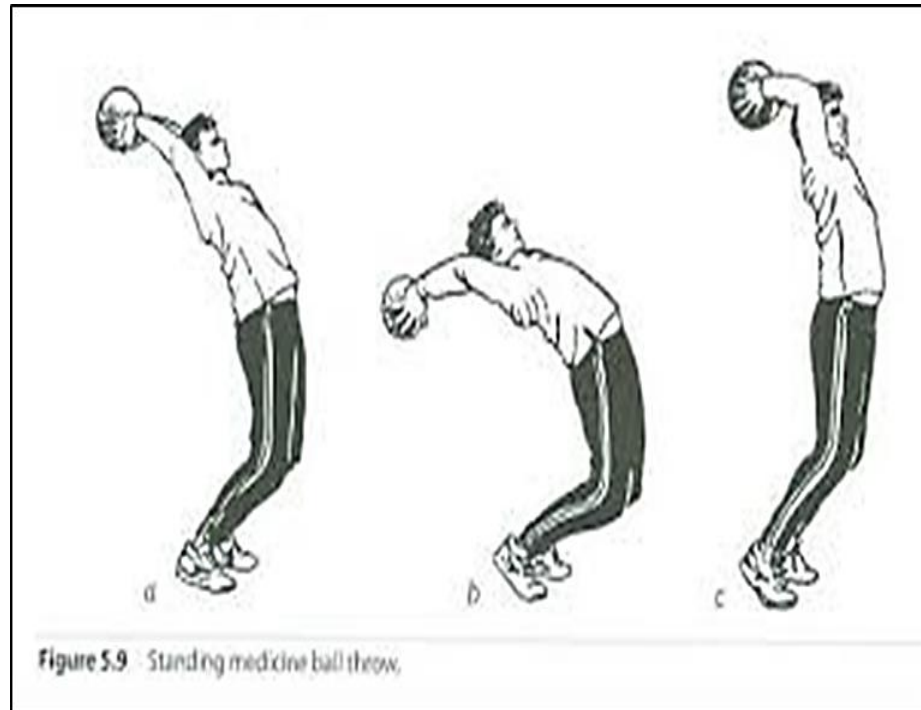


Fig. II- Illustration of overhead medicine ball throw

3. The vertical jump known as the “Sargent” jump was used to measure lower body strength. **Equipment:** Measuring tape or marked wall, chalk for marking wall. **Procedure:** The participants stood side on to a wall and reach up with the hand closest to the wall. The participants, keeping the feet flat on the ground with chalk in one hand raised that hand and mark the wall at the highest point without tiptoeing. This is called the standing reach height. The participants then stood away from the wall (side to the wall), and took a leap vertically as high as possible using both arms and legs to assist in projecting the body upwards (from a semi squat position) and marked the wall at the highest point of the jump. This was the jumping reach height. The difference in distance between the standing reach height and the jump reach height was recorded as the score in cm. The better of two attempts was recorded as a distance score.

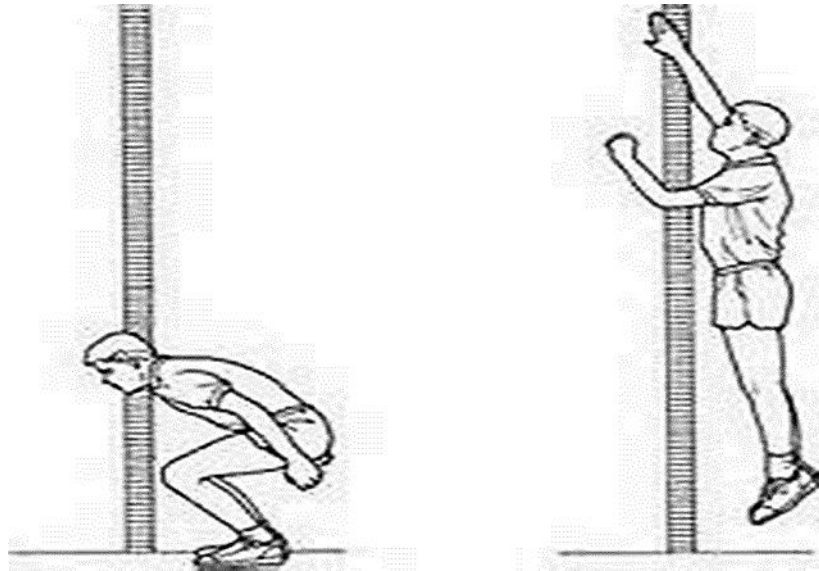


Fig. III- Illustration of vertical jump

Validity of the Instrument

The tests and equipment used in this study are already standardized instruments with. However, they were tested and inspected by the researcher and assistants during the pilot study to ensure that they were in good working conditions for use during the data collection.

Reliability of the Instrument

The research instruments are all standardized with their respective psychometric properties. Vertical jump test and medicine ball throw had reliability coefficients of 0.993 and 0.996 respectively in a study by Stockbrugger and Haennel (2001) for explosive power test. This makes them conducive enough a test to use for the study. The Illinois agility test has been used in several studies and in one of these studies, the intra-class reliability was quoted as 0.96 (Hachana, et al., 2013; Hachana, et al., 2014).

Pilot Study

A pilot study was conducted before the main study using ten students from the Department of Health Physical Education and Recreation who were

not part of the sample for the study. The pilot study was conducted to find out if the test instruments were in good conditions. Also, they were taken through all the tests and treatment as will the participants for the actual study to ascertain feasibility in their use for the study. Again, the pilot study provided an opportunity to identify problems that could occur during the actual study.

Five research assistants were used during the pilot study as had been speculated for the main study. These research assistants were carefully selected by the researcher to ensure that they could adequately help the researcher collect accurate data. On arrival, the participants were briefed and the physical characteristics measured as well as physiological variables of heart rate and blood pressure. Participants were then taken through the performance tests. Treatment was administered and the participants relaxed for 60 minutes after which they warmed up and went into the post test. They were given snacks and they left.

The pilot study gave the researcher the opportunity to know the time it took to take one participant through the exercise test which was up to one hour thirty minutes, the need to engage the participants in some kind of talk during the resting period between the treatment and the post-test as they got bored during the wait and the need for the participants to warm up well before going through the performance tests. It was also realised during the pilot study that in order to perform the agility test on the tennis court with no slips, participants had to be informed to put on footwear with good grips and this information was passed on to the actual participants for the main study. Again, it was realised that one more research assistant was needed for the main study.

This was to allow room for the researcher to well monitor the work they were doing to ensure correct measurements.

Data Collection Procedures

The researcher met the participants on two separate occasions for about four hours within a two-week period. During the first session the experimental protocol was explained to the prospective participants, they also signed an informed consent form and their height and weight were measured. Participants were also required to fill out a medical history form and a physical activity readiness questionnaire. Demographic data was also collected.

Participants had already been fully informed of the risks, benefits, confidentiality, and the participant's responsibilities were discussed at length through which the researcher and the participants reached an agreement on the behaviour of the researcher, her assistants and the participants during the study. The second session consisted of the experimental trial during which the actual data collection took place.

Dietary Intake: The participants were asked to refrain from eating anything one hour prior to the trial but must adequately eat a balanced diet before that time (Stewart, 2001). They were also asked to refrain from caffeine containing food 48 hours prior to the trial because the half-life of caffeine is about four to six hours (Graham, 2001).

Participant's Responsibilities: The participants were asked to put in maximal effort during the exercise tests as this was the only way the data collected would be a true representation of their performances. Participants were also expected to observe the following responsibilities: refrain from food

two hours prior to each trial and also report any discomforts to the researcher or her assistants if there was any. Participants were informed that they could back out of the research at any time during the study if they did not feel up to it.

Confidentiality: While confidentiality of results was maintained, participants could inquire about their individual performance scores. Each participant was told they would have the opportunity to benefit from knowledge of the physical variables influencing their sports abilities. The participants were identified by code and individual results obtained from the test protocols. However, overall results of the study were made available to the public.

Experimental trial: On the day of the trial, each participant was taken through pre-test and post-test measurements and also given the same treatment protocol. Paton, Lowe and Irvine (2010) mentioned in their study that use of caffeine-containing energy drinks containing lower doses of caffeine (1–3 mg/kg body weight) is more practical due to their availability and minimal side effects. Therefore, the volume of the energy drink was set at a dose of 250-mL serving of Red Bull energy drink containing 80 mg of caffeine (Buxton, & Hagan, 2012) and was administered 60 minutes before the post-test measurements (Del Coso et al. 2012). The experimental trial consisted of a warm-up and stretch period, a pre-test protocol, intervention, rest, warm up, a post-tests protocol and a cool down. At the beginning of each post-test trial, the participants consumed 250ml of Red Bull and waited for sixty (60) minutes before proceeding on to the post-tests. The warm-up was about five

minutes where the participants went through general warm-up exercises and then stretching. The day's activities were outlined as follows:

1. Arrival
2. Briefing
3. Measurement of physiological variables and physical characteristics
4. Warm up
5. Pre testing: Illinois agility test, vertical jump test and overhead medicine ball throw.
6. Measurement of physiological variables
7. Treatment/ Intervention
8. Briefing/ waiting period
9. Warm up
10. Post Testing; Illinois agility test, vertical jump test and overhead medicine ball throw.
11. Measurement of physiological variables
12. Cool down
13. Refreshment
14. Departure

Data Processing and Analysis

Data were collected from one group which went through two measures therefore the analysis was done by comparing means within the group. Paired sample t-test was used to find the difference in means of pre-test and post-test measurements of each test variable in hypotheses one to six. Hypothesis seven was analysed using the independent sample t-test. This was done to compare

the means between two independent groups, male and female. The level of significance used to reject the null hypotheses was $p < 0.05$.

Chapter Summary

The research method used involved a single selected group under observation, with a careful measurement being done before applying the experimental treatment and then measuring after. This research design used has minimal internal validity, controlling only for selection of subject and experimental mortality. It has no external validity and due to its experimental nature, findings cannot be generalized to other populations. Testing the participants two or three times would have been ideal but it was difficult to get the students to perform the activities repeatedly. Also, dietary behavior of the participants before the experiment could have influenced the effect of the energy drink on the athletes. Again, findings could be as a result of participants becoming familiar with performance tests since they could have been motivated from their first trial to do better in the second.

CHAPTER FOUR

RESULTS AND DISCUSSION

The purpose of this study were to examine the acute effect of energy drink consumption on systolic and diastolic blood pressure and heart rate and to determine if energy drink consumption improves agility, upper body and lower body strength. This chapter focuses on presentation of results and result interpretation. Findings of the results were discussed in relation to existing literature.

Hypothesis 1: Short Term Consumption of Energy Drink has No Significant Effect on Systolic Blood Pressure

The resting systolic blood pressure of the athletes ranged from 100 to 161 (61) mmHg with a standard deviation of 14.58. Systolic blood pressure was measured after the pre-test and the mean of the recorded values which ranged from 93 to 157 (64) mmHg was found to be 126.3 mmHg and the standard deviation, 14.10. Systolic blood pressure was again measured after the post-test and the blood pressure ranged from 103 to 160 (57) mmHg with a mean of 128.27 mmHg and a standard deviation of 12.94.

A paired sample t-test was conducted comparing the means of the resting systolic blood pressure and the systolic blood pressure after pre-test where no interventions were given and also the resting systolic blood pressure and the systolic blood pressure after the post-test which took place after the intervention for the experiment had been given. The output from the data analysis is shown in the table 3 below.

Table 3- *T-test analysis results for differences between resting systolic blood pressure and systolic blood pressure after pre-test and post-test*

Variables	SBP		t	df	Sig. (2 tailed)
	M	SD			
Resting SBP	124.41	14.58			
SBP after pre test	126.34	14.10	-0.87	43	.389
SBP after post test	128.27	12.27	-1.53	43	.133

Source: Field data, Kluboito (2016)

The paired sample t-test showed no significant differences between resting systolic blood pressure and systolic blood pressure after pre-test. This implies that there were improvements in the systolic blood pressure of the participants after going through the performance tests but these improvements were not statistically significant.

Also, there was no significant difference in resting systolic blood pressure and systolic blood pressure after post-test. Improvements in the systolic blood pressure after the post-test were also not statistically significant when compared the systolic blood pressure at rest.

To test the hypothesis on the effect of short term energy drink consumption on systolic blood pressure, a paired sample t-test was again conducted to find the differences in systolic blood pressure measurements after the pre-test and after the post-test labelled in table 4 below as SBP1 and SBP2 respectively.

Table 4- *T-test analysis results for effect of energy drink on systolic blood pressure*

Variable	Condition		t	df	Sig. (2 tailed)
	SBP1	SBP2			
Systolic blood pressure	126.34 (14.10)	128.27 (12.94)	-0.78	43	0.437

Source: Field data, Kluboito (2016)

There was no significant difference in SBP1 and SBP2 with a p value of .437. This result indicates that short term consumption of energy drink does not have any significant effect on systolic blood pressure. Therefore, the researcher failed to reject the null hypothesis.

Hypothesis 2: Short Term Consumption of Energy Drink has No Significant Effect on Diastolic Blood Pressure

The diastolic blood pressures of the athletes as recorded at rest ranged from 52 to 135 mmHg with a mean of 75.09 mmHg and a standard deviation of 14.60. Diastolic blood pressure recorded after pre-test ranged from 51 to 130 mmHg with a mean of 75.73 mmHg and a standard deviation of 16.06. Also, the diastolic blood pressure after post-test ranged from 56 to 135mmHg with a mean of 78.16mmHg and a standard deviation of 13.45.

A paired sample t-tests were conducted to find mean differences between resting diastolic blood pressure and the diastolic blood pressure after pre-test, as well as resting diastolic blood pressure and diastolic blood pressure after post-test.

Table 5- *T-test analysis results for differences between resting diastolic blood pressure and diastolic blood pressure after pre-test and post-test*

Variables	DBP		t	df	Sig. (2 tailed)
	M	SD			
Resting DBP	75.09	14.60			
DBP after pre test	75.72	16.06	-0.21	43	.835
DBP after post test	78.15	13.44	-1.03	43	.309

Source: Field data, Kluboito (2016)

The paired sample t-test showed no significant differences in resting diastolic blood pressure and diastolic blood pressure after pre-test. Also, there was no significant difference in resting diastolic blood pressure and diastolic blood pressure after post-test.

To test the hypothesis effect of short term energy drink consumption on diastolic blood pressure, a paired sample t-test was again conducted to find the differences in diastolic blood pressure measurements after the pre-test and after the post-test labelled DBP1 and DBP2 respectively. Table 6 below shows the data output for the analysis.

Table 6- *T-test analysis results for effect of energy drink on diastolic blood pressure*

Variable	Condition		t	df	Sig. (2 tailed)
	DBP1	DBP2			
Diastolic blood pressure	75.72 (16.06)	78.15 (13.44)	-0.91	43	0.366

Source: Field data, Kluboito (2016)

There was no significant difference in DBP1 and DBP2. The diastolic blood pressures of the participants were not statistically significantly affected following the consumption of energy drink. The researcher therefore failed to reject the null hypothesis.

Hypothesis 3: Short Term Effect of Energy Drink has No Significant Effect on Heart Rate

The heart rates (bpm) were recorded for each participant at rest, after pre-test and after post-test. The resting heart rate recorded from 47 to 98 bpm with a mean of 72.36 bpm and a standard deviation of 12.77. The heart rate after pre-test ranged from 52 to 107 bpm with a mean of 83.73 bpm and a standard deviation of 12.22. Heart rate after post-test ranged from 52 to 107 bpm with a mean of 84.27 bpm and a standard deviation of 13.33.

A paired sample t tests was conducted to find mean differences between resting heart rate and the heart rate after pre-test as well as resting heart rate and heart rate after post-test. Results are shown in the table 7 below.

Table 7- *T-test analysis results for differences between resting heart rate and heart rate after pre-test and post-test*

Variables	Heart rate		t	df	Sig. (2 tailed)
	M	SD			
Resting Heart rate	73.36	12.76			
Heart rate after pre test	83.72	12.22	-8.25	43	.001
Heart rate after post test	84.27	13.33	-6.32	43	.001

Source: Field data, Kluboito (2016)

There was significant difference in resting heart rate and heart rate after pre-test. Also, there was significant difference in resting heart rate and heart rate after post-test. The paired sample t-test showed significant differences in heart rate when comparing the resting heart rate and the post-exercise values for both the pre-test and post-test.

To test the hypothesis effect of short term energy drink consumption on heart rate, a paired sample t-test was again conducted to find the differences in heart rate measurements before and after the pre-test and after the post-test (HR1 and HR2). The table below shows the SPSS output for the analysis.

Table 8- *T-test analysis results for effect of energy drink on heart rate*

Variable	Condition		t	df	Sig. (2 tailed)
	HR1	HR2			
Heart rate	83.72 (12.22)	84.27 (13.33)	-0.30	43	.759

Source: Field data, Kluboito (2016)

There was no significant difference in HR1 and HR2. The heart rate changes after pre-test and after post-test were not statistically significantly different. Therefore, the researcher failed to reject the null hypothesis.

Hypothesis 4: Short Term Consumption of Energy Drink has No Significant Effect on Agility.

The results of the agility test times during the pre-test ranged from 16.46 to 24.08 seconds with a mean of 7.62s a standard deviation of 1.73. This indicates that the group was reasonably homogeneous in their agility ability. There were considerably better times recorded during the post-test ranging

from 16.37s to 23.35s with a mean of 6.98s standard deviation of 1.55. A paired sample t-test was conducted to compare the results for the agility test without energy drink (pre-test) and with energy drink (post-test).

Table 9- *T-test analysis results for effect of energy drink on agility*

Variable	Condition		t	df	Sig. (2 tailed)
	Pre-test	Post-test			
Agility	18.88 (1.73)	18.46 (5.42)	5.42	43	0.000

Source: Field data, Kluboito (2016)

There was a significant difference in the results for pre-test and post-test. This implies that the consumption of energy drink had a significant effect on agility running time of the participants. Therefore, the null hypothesis is rejected.

Hypothesis 5: Short Term Consumption of Energy Drink has No Significant Effect on Lower Body Strength.

The results of the vertical jump test ranged from 23 to 71 cm with a mean of 48.00cm and a standard deviation of 11.29 for the pre-test. For the post-test, the results ranged from 16.37 to 23.35cm with a mean of 47.00cm with a standard deviation of 11.46. A paired sample t-test was conducted to compare the results for the vertical jump test without energy drink (pre-test) and with energy drink (post-test).

Table 10- *T-test analysis results for effect of energy drink on lower body strength*

Variable	Condition		t	df	Sig. (2 tailed)
	Pre-test	Post-test			
Lower body strength	45.75 (11.29)	45.65 (11.46)	0.11	43	0.916

Source: Field data, Kluboito (2016)

There was not a significant difference in the results for pre-test. This implies that the consumption of energy drink did not have a significant effect on lower body strength of the participants. Therefore, the researcher failed to reject the null hypothesis.

Hypothesis 6: Short Term Consumption of Energy Drink has No Significant Effect on Upper Body Strength.

The results of the overhead medicine ball throw distances ranged from 2 to 9.4 meters with a mean of 7.40m and a standard deviation of 1.58 for the pre-test and 3.02 to 9.59 meters with a mean of 6.57m and a standard deviation of 1.63 for the post-test. A paired sample t-test was conducted to compare the results for the overhead medicine ball throw without energy drink (pre-test) and with energy drink (post-test).

Table 11- *T-test analysis results for effect of energy drink on upper body strength*

Variable	Condition		t	df	Sig. (2 tailed)
	Pre-test	Post-test			
Upper body strength	5.25 (1.57)	5.52 (1.62)	-2.79	43	0.008

Source: Field data, Kluboito (2016)

There was a significant difference in the results for pre-test and post-test. This implies that the consumption of energy drink had a significant effect on upper body strength of the participants. Therefore, the null hypothesis is rejected.

Hypothesis 7: There is No Significant Difference in The Effect of Short-Term Energy Drink Consumption on Variables Between Male and Female Athletes.

Hypothesis seven which states that there is no significant difference in the effect of short-term energy drink consumption on agility, upper body strength and lower body strength between male and female athletes was formulated to find out if the effects the energy drink had on the post-test performance would be different between the male and female participants. This hypothesis was tested using the independent sample t-test and the SPSS output is shown in the table below.

Table 12- *T-test analysis results for difference in effect of energy drink on performance variables between male and female participants*

Variables	Mean difference	t	df	Sig. (2 tailed)
Agility	-0.17	-1.13	42	.264
Upper body strength	-1.13	-1.77	42	.085

Source: Field data, Kluboito (2016)

There was no significant difference in the result for agility for male and female participants with an alpha value of $p = .264$. Implying that the effect of short term consumption of energy drink on agility was not different between males and females. Also, there was no significant difference in the results for upper body strength for male and female participants with an alpha value of $p = .085$. This result indicates that the effect of short term consumption of energy drink on upper body strength is not different between males and females. The results for lower body strength were not analysed because the results were not statistically significant from the paired sample t test.

Discussion

The present study was an investigation of the effect of energy drink on the physiological responses and physical performance variables of athletes of the University of Cape Coast. Red Bull energy drink was used for this study, the physiological responses examined were blood pressure and the physical performance variables were agility, vertical jump and overhead medicine ball throw. The investigation was done without altering the participant's dietary routine. However, the participants fasted for a short while which was practically close to the length of fasting prior to a competition.

The parameters measured in this study were measured using basic skills and activities that are performed in each of their respective sports. Several researchers have investigated the effects of one energy drink or the other on several sports, physiological responses and physical performance variables using several experimental protocols. For this study, forty-four athletes, twenty-two males and twenty-two females between the ages of 18 and 33 years participated. The study was a one group pre-test – post-test one. Participants reported to the tennis court of the University of Cape Coast on the day of the experiment where their heights, weights, blood pressure and heart rates were measured. The participants were taken through the pre-test measurements after which their blood pressures and heart rates were measured again. The Red Bull was then administered to the athletes. The participants took rest for 60 minutes to allow the energy drink be absorbed into the system. After the 60 minutes, they went into the post-test. The physiological parameters were once again measured after the post-test.

Physiological Responses

No significant changes were found in the heart rates, systolic and diastolic blood pressure after the ingestion of energy drink. This could be as a result of the fact that the participants were trained athletes with improved physiological variables. The warm up, the exercise tests and the intervention together before the post-test were enough to cause changes in the systolic blood pressure but this increase was statistically significant. Also, the performance tests were short duration tests.

Contrary to this finding, caffeine was found to have caused a significant increase in the mean heart rate after 60 minutes of ingestion in a

twenty male volunteers in a study by Geethavani, Rameswarudu and Rameshwari Reddy (2014). Also, there was a significant difference in the systolic blood pressure recorded in the study (Caffeine caused significant increase in the mean systolic blood pressure (60 minutes' post ingestion) from 116.6 to 128.3 mmHg as compared to placebo conditions. The mean rate increased from 72.9 to 77.3 Bpm in test group (no change was observed in control group). Caffeine again caused significant increases in systolic blood pressure (SBP) (20 and 40 min post ingestion) and maximal arterial pressure (MAP) (40 min post ingestion) compared with placebo conditions (Daniels, Mole, Shaffrath & Stebbins, 1998). During dynamic exercise plus caffeine, SBP and MAP were higher than in placebo conditions at 60 min post ingestion. However, the magnitude of caffeine induced was found to increase resting and exercise blood pressure but they were not significantly different from respective control conditions. Furthermore, no statistical interaction was found between the effects of caffeine and exercise on blood pressure. Also, in a study by Goldstein et al. (2010), diastolic blood pressure and heart rate were unaffected by caffeine. Systolic blood pressure was however significantly greater in post-exercise with caffeine ($p < 0.05$) (116.8 ± 5.3 mmHg vs. 112.9 ± 4.9 mmHg) in a study by Goldstein et al. (2010). All these studies have shown contradictory effects of caffeine and energy drink on physiological responses during exercise. Treatments in these studies were administered between thirty to sixty minutes' post exercise similar to this study and most other studies out there (Dawes et al., 2014, Stojanovic et al., 2011, Del Coso et al., 2012).

According to Reissig et al. (2009), when caffeine enters the blood, it makes the body think it is in an emergency and the pituitary gland initiates the body's fight or flight response by releasing adrenaline. This hormone makes the heart beat faster. Keeping this in mind, significant change in the heart rate of the participants after the consumption of the energy drink was expected. This outcome could be associated with the amount of energy drink (250ml) that was consumed in this study and caffeine content (80mg). For studies which recorded significant changes in the heart rate and blood pressure, the amount of caffeine consumed was up to 6mg/kg as compared to 80mg/250ml of caffeine containing energy drink in this study.

However similar to this study, an independent study by Apatov et al. (2011), in which they investigated the physiological effects of 5-hour energy drink on regular consumers, diastolic blood pressure was found not to be statistically affected by the consumption of the energy drink. Consistent with this data is a study by Daniels et al (1998) which also found that the magnitude of caffeine induced increases in resting and exercise diastolic blood pressure were not statistically different from respective control conditions. Again, in a study by Goldstein et al. (2010), diastolic blood pressure was unaffected by the consumption of caffeine.

Polinski et al (2011) in their study on the analysis of correlation between heart rate and blood pressure found correlations between the two variables, but this correlation was found to be in-consistent and varied from measurement to measurement. It is therefore understandable that there was a no significant change in the heart rate and blood pressure after the intervention. An et al. (2014) in the conclusion of their study stated that low

dose caffeine produces no particular difference in heart rate at rest. In this study however, the heart rate was not measured at rest after the consumption of the energy drink indicating that there could be a significant change when the heart rate is measured after exercise. The inconsistency in the literature regarding the changes that caffeine and energy drink causes in heart rate and blood pressure still continues as the results from this study adds to the negative findings that already exist. Nti et al. (2014) in their study had reported that 75% of the participants had increased heart rates as a result of the consumption of energy drinks. These participants were not athletes unlike the participants of this study, nor did they report that they felt this after going through physical activity.

Physical Performance Variables

The physical performance variable agility has been sparingly investigated into when it comes to investigations into the effects of energy drink on the performance variables. For this study however, athletes were taken through the Illinois agility test before and after the consumption of Red Bull energy drink and the results compared using the paired sample t-test. It was found that the changes in the results for the agility tests of participants were statistically significant with a p value of $p \leq 0.00$ at an alpha level set at $p \leq 0.05$. This result implies that agility was a 100% affected by the consumption of Red Bull energy drink. Variables which are close to agility that is including the components of agility (speed and change of direction) have been investigated into. In Del Coso et al.'s (2012) research into the effect of caffeine containing energy drink on simulated soccer performance, they investigated as part of their study the effect of Red Bull energy drink on the

number of sprints run by their participants in a simulated soccer performance. These sprints in the game could be related to agility as running pattern in soccer involves change of direction. The mean running speed during the speed test in this study was also increased as a result of the consumption of the energy drink as against the placebo given. Contrary to the results for this study and the study by Del Coso et al., energy drink treatment did not have any significant effect on reactive sprint test of participants in a study to investigate the effects of a pre-workout energy drink on measures of physical performance by Dawes et al. (2014). Similarly, a pre workout consumption of energy drink by participants in another study by Paez et al. (2014) did not cause any significant change in the time taken to complete the test. Issues about reaction time could also be considered in this discussion of agility test results as the participants had to respond to the stimuli for the start in order to make a good time on the agility test.

It was reported in a study by Duvnjak-Zaknich et al. (2011), that there is improved interpretation and response to stimuli of an individual after ingesting caffeine. Their study was to investigate the effect of caffeine on reactive agility time when fresh and fatigued, and faster times were recorded for the reactive agility tests were consistently faster after the ingestion of caffeine. A similar study conducted by Jordan (2012) who tried to find out of reactive agility through the dominant and non-dominant side and found that caffeine supplementation significantly improved players' reaction times to their non-dominant side. This goes to imply that energy drink has been found to improve agility in most studies even though there are still some studies in

which agility in whichever form it was had been unaffected by pre-workout energy drink consumption.

Lower body strength was tested in this study using the vertical jump test. A statistical significance value of 0.458, the vertical jump test showed no significant difference after the consumption of energy drink. This implies that the energy drink treatment had no effect on the lower body strength (vertical jump). Similarly, energy drink treatment did not enhance vertical jump performance in the participants of the study by Dawes et al. (2014). Del Coso et al. (2012) also found similar results in their study. Stojanovic et al. (2011), had also tested lower body strength using vertical jump and analyses of variance conducted revealed no differences between placebo and supplement group in vertical jump. Contrary to the results from this study however, increments in the mean jump height of participants after ingesting energy drink in comparison to a placebo was found in a study by Del Coso et al. (2012).

Upper body strength was found to be significantly affected by the short term consumption of energy drink. This result could be attributed to the age and metabolism of the athletes. Upper body strength in most researches have been tested using other activities such as bench press and hand grip strength test. In Eckerson et al.'s (2011) study, they tested upper body strength using bench press. Participants had to do a 1RM bench press after consuming energy drink and no effect was found. Stojanovic et al. (2011) tested hand grip in their study the results also showed no significant improvements in performance. Similarly, a moderate dose of caffeine was found to enhance strength performance of resistance trained women in a one repetition maximum barbell

bench press test in a study by Goldstein et al. (2010). These results are in agreement with the result of this study. These results are in disagreement with Astorino et al. (2008) as the authors of that investigation reported no significant increase in upper body strength in resistance trained males after consuming 6 mg/kg of caffeine. Similar to the overhead medicine ball throw which was used in this study to test for upper body strength, ballistic bench throw was used by Krammerer et al. (2012) and the caffeine ingested caused a significant increase in the peak performance, peak power and peak velocity.

The outcomes of research investigations that have examined the effects of caffeine ingestion on strength have been inconsistent and most administered caffeine in capsule forms. For this study however, the caffeine was consumed in one 250-mL serving of Red Bull energy drink containing 80 mg of caffeine. Despite the fact that the caffeine dosage for this study was relatively low, there still were significant changes in agility and upper body strength after the ingestion of energy drink. Lower body strength on the other hand was not increased with the ingestion of the energy drink.

The purpose for this study was to conduct research under condition that are as close to what the Ghanaian athlete usually does hence the reason for this dosage and as Paton et al. (2010) had said, use of caffeine-containing energy drinks containing lower doses of caffeine (1–3 mg/kg body weight) is more practical due to their availability and minimal side effects. Therefore, the athletes' usual choice of caffeine intake was considered for this study. This dosage and the conditions under which the performance test were conducted could be a great influence to the outcomes of the study.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study were to examine the acute effect of energy drink consumption on systolic and diastolic blood pressure and heart rate and to determine if energy drink consumption improves agility, upper body and lower body strength. This chapter focuses on the summary, conclusions and recommendations of the study.

Summary of the Study

The use of energy drink by athletes as a supplement has become popular among athletic populations. It has gradually become a common practice for athletes to consume energy drink prior to competition, yet literature regarding the effect of energy drink on performance are inconsistent especially in short duration high intensity events. Ghanaian athletes who were the participants for this study usually consume up to 250-300 ml of energy drink going into events. The purpose for this study was to conduct research under condition that is as close to what the Ghanaian athletes usually do. Therefore, dosage of 250 ml serving of Red Bull energy drink containing 80 mg of caffeine was administered. Paton et al. (2010) had said that use of caffeine-containing energy drinks containing lower doses of caffeine (1–3 mg/kg body weight) is more practical due to their availability and minimal side effects. Therefore, the athletes' usual choice of caffeine intake was considered for this study. The need for an experiment to be conducted under conditions that are as close to the usual for most athletes informed the choice of the research and methodology adopted. To achieve this, seven hypotheses

were formulated to test for the effect of short term consumption of energy drink on variables of interest.

The study adopted a one group pre-test - post-test experimental research design. It was delimited to the athletes of the University of Cape Coast and it involved the examination of the ergogenic effect of Red Bull energy drink. Forty-four participants volunteered for the study and were given all the information they needed before the day of data collection. Data collected was screened and analysed using the student t-test.

Key Findings

All the physiological measurements were not significantly affected by the ingestion of energy drink. These results may be applied to alter pre-exercise consumption of energy drink. Again, 250ml of energy drink was not enough to cause significant elevations in the blood pressure and heart rates of the athletes implying that this dosage may be a safe dosage to use for short term supplementation with minimal physiological effects.

For the physical performance variables, significant changes were recorded after the ingestion of energy drink in the agility and upper body strength but not the lower body strength. The effect was also found not to be different for males and females.

Results of this study suggest that healthy athletes do experience performance benefits from short term energy drink supplementation when consumed before performing short term exercise in this case, agility and upper body strength exercise. However this short term supplementation does not have performance benefits on lower body strength.

Conclusions

1. Healthy athletes do experience performance benefits from Red Bull supplementation when consumed shortly before performing exercise in this case, agility and upper body strength exercise tests.
2. This supplementation however does not have performance benefits on lower body strength.
3. 250ml of Red bull energy drink does not cause significantly high elevations in blood pressure and heart rate of athletes.
4. Male and female athletes do not have different responses to energy drink in this case, to its effect on agility and upper body strength.

Athletes who consume energy drink for a short term in competition have no advantage over their fellow athletes who compete without energy drink for events in which lower body strength is predominant therefore, they should reconsider as the short term consumption of energy drink does not have significant effect on lower body strength.

Recommendations

These results may have application for altering pre-exercise energy drink intake in competitive and recreational athletes. Based on the findings of this research,

1. Trainers and coaches could consider recommending the use of the commercially available energy drink as a short term pre-exercise supplement, especially in events in which agility and upper body strength are key.
2. Athletes who wish to enhance their performances using energy drink can do so knowing that the short term consumption of energy drink

does not have significant effect on their physiological responses (blood pressure and heart rate) during performance.

Suggestions for Further Studies

Future research interventions could focus on

1. The various potential performance enhancing ingredients (caffeine, taurine, and glucose) contained in the energy drinks,
2. Comparing the effects of energy drink at various caffeine dosages on sports performance,
3. The effects of energy drink as part of training regimen on the performance of athletes,
4. An investigation of the nature and mechanisms surrounding energy drink supplementation to help identify the adaptations necessary for training and improved sport performance.

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APPENDICES

APPENDIX A

RECORDING SHEET (PRETEST AND POSTTEST)

Participant's number: Date:

Name: (Optional)

Age: Gender:

Height: Weight:

Resting BP: Resting HR:

EXERCISE MEASURES

First trial (Pre-test) Results

Illinois Agility Test:

Vertical Jump Test:

Overhead Medicine Ball Throw:

BP: HR:

Second trial (Post-test) Results

Illinois Agility Test:

Vertical Jump Test:

Overhead Medicine Ball Throw:

BP: HR:

Research Assistant:

APPENDIX B

Physical Activity Readiness Questionnaire (PAR-Q)

If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you significantly change your physical activity patterns. Common sense is your best guide when answering these questions. Please read carefully and answer each one honestly: circle **YES** or **NO**.

1. Has your Doctor ever said you have a heart condition and that you should only do physical activity recommended by a Doctor? Yes/No
2. Do you feel pain in your chest when you do physical activity? Yes/No
3. In the past month, have you had chest pain when you were not doing physical activity? Yes/No
4. Do you lose balance because of dizziness or do you ever lose consciousness? Yes/No
5. Do you have a bone or joint problem (for example, back, knee, or hip) that could change in your physical activity such as this one? Yes/No
6. Is your Doctor currently prescribing medication for your blood pressure or heart condition? Yes/No
7. Do you know of any other reason why you should not do physical activity? Yes/No

(**Yes** to one or more questions, you should consult with your Doctor to clarify that it is safe for you to become physically active at this current time and in your current state of health.

No to all questions, it is reasonably safe for you to participate in physical activity, gradually building up from your current ability level. A fitness appraisal can help determine your ability levels)

I have read, understood and accurately completed this questionnaire. I confirm that I am voluntarily engaging in an acceptable level of exercise, and my participation involves a risk of injury.

Signature:

Name:

Date:

Name and Signature of witness:

APPENDIX C
UNIVERSITY OF CAPE COAST
INSTITUTIONAL REVIEW BOARD
INFORMED CONSENT FORM

Title: Effects of energy drink on physiological responses and physical performance variables of athletes of the University of Cape Coast.

Principal Investigator: Yayra Kluboito

Address: University of Cape Coast.

Department of Health Physical Education and Recreation,
University of Cape Coast, Cape Coast

General Information about Research

My name is Yayra Kluboito, an M.Phil. (Physical Education) student at the Department of HPER, UCC. I am conducting a research study on: **“Acute Effect of energy drink on physiological responses and physical performance variables of University athletes”**. To find answers to some of these questions, I am inviting you to participate in this research project. You will be required to complete some exercise protocols (agility test, vertical jump test and overhead medicine ball throw) twice. Once for the pre-test and again after taking the treatment (energy drink). Your blood pressure and heart rate will be measured as part of this study.

You are being invited to participate in this research project because I feel that your experience as an athlete will contribute much to this study. You have been selected from a number of athletes and the results from your test will be analysed as a group.

Procedures

If you accept, you will be required to go through some physical activity. The physical activity will be in the form of agility test, vertical jump test and overhead medicine ball throw. You will also be required to consume an amount of energy drink as a treatment for the study.

Possible Risks and Discomforts

There could be cases of tiredness due to exercise tests and also some uneasiness could result from the consumption of the energy drink

Possible Benefits

This study will help increase your knowledge as a participant on the effects that energy drink has on your physiological responses and state of physical activity.

Confidentiality

I will protect information about you to the best of ability. You will not be named in any reports. Some staff of the Department of HPER, UCC and my supervisor may sometimes look at your research records.

Compensation

Participants will be refreshed (with a snack) after the data collection process.

Staying in the Research

This research will involve a pre-test and post-test and participants will be expected to take part in both tests.

Voluntary Participation and Rights to leave the Research

Participants can withdraw from participating in the study at any point without being penalized.

Termination of participation by the Researcher

Any participant that is found to have consumed any substance that could endanger him or her during the data collection will be excluded from the study.

Contacts for Additional Information

For answers to pertinent questions about the research and in case of research-related injury, contact Yayra Kluboito on 0275296709.

Your rights as a Participant

This research has been reviewed and approved by the Institutional Review Board of the University of Cape Coast (UCCIRB). If you have any questions about your right as a research participant, you can contact the administrator of the IRB office between the hours of 8:00am and 4:30pm through the phone lines 0332133172 and 0244207814 or email address: irb@ucc.edu.gh.

VOLUNTEER AGREEMENT

The above document describing the benefits, risks and procedures for the research title “Effect of energy drink on physiological responses and physical performance variables of athletes of the University of Cape Coast” has been read and explained to me. I have been given an opportunity to ask any questions about the research answered to my satisfaction. I agree to participate as a volunteer.

.....

.....

Date

Name and signature or mark of volunteer

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

.....

.....

Date

Name and signature of person who obtained consent

APPENDIX D

INTRODUCTORY LETTER

UNIVERSITY OF CAPE COAST
COLLEGE OF EDUCATION STUDIES
Department of Health, Physical Education & Recreation

TELEPHONE: 233 - 0332130634M, 32480-9 Ext.253
TELEX: 2552, UCC, GH.



Cables & Telegrams:
UNIVERSITY, CAPE COAST

Ref: ED/MPE/13/0002/8

9th October, 2015

Ag. Sports Coach
Sports Section
University of Cape Coast

INTRODUCTORY LETTER

The bearer of this letter, Ms Yayra Kluboito with Index Number ED/MPE/13/0003, is a student of the above-named department who is pursuing Master of Philosophy (Physical Education) programme. She is conducting a research on **'Effect of energy drink on physiological responses and physical performance variables of athletes of the University of Cape Coast'** for which she may require assistance from your outfit.

We would therefore be very grateful if she is given the needed help from your section.

We count on your usual co-operation.

Thank you.



Dr. Charles Domifeh

For: Head of Dept.

APPENDIX E
ETHICAL CLEARANCE

UNIVERSITY OF CAPE COAST
INSTITUTIONAL REVIEW BOARD SECRETARIAT

TEL: 03321-33172/3 / 0207365663/ 0244207814

C/O Directorate of Research, Innovation and Consultancy

E-MAIL: irb@ucc.edu.gh

OUR REF: UCC/IRB/3/37

YOUR REF:



20TH NOVEMBER, 2015

Ms. Yayra Kluboito
Department of Physical Education and Recreation
University of Cape Coast

Dear Ms. Kluboito,

ETHICAL CLEARANCE –ID NO: (UCCIRB/CES/2015/01)

The University of Cape Coast Institutional Review Board (UCCIRB) has granted **Provisional Approval** for implementation of your research protocol titled **“Effects of energy drink on physiological response and physical performance variables of athletes of University of Cape Coast.”**

This approval requires that you submit periodic review of the protocol to the Board and a final full review to the UCCIRB on completion of the research. The UCCIRB may observe or cause to be observed procedures and records of the research during and after implementation.

Please note that any modification of the project must be submitted to the UCCIRB for review and approval before its implementation.

You are also required to report all serious adverse events related to this study to the UCCIRB within seven days verbally and fourteen days in writing.

Always quote the protocol identification number in all future correspondence with us in relation to this protocol

Yours faithfully,

SIGNED

Samuel Asiedu Owusu

Administrator

cc: The Chairman, UCCIRB