Original Article

Effects of long-term consumption of energy drinks on the body and brain weights of adult Wistar rats

Josiah Obaghwarhievwo Adjene, Victor Emojevwe, David Eseoghene Idiapho[1]

Department of Medical Laboratory Science, Achievers University, Owo, Ondo State, [1]Department Of Histopathology, Federal Medical Centre, Yenagoa, Bayelsa State, Nigeria

Abstract

Background: Effects of long-term consumption of energy drinks commonly used as flavored beverage drinks on the body and brain weights of adult Wistar rats was carefully studied. **Materials and Methods:** Twenty adult Wistar rats, with average weight of 200 g were randomly assigned into treatment (n = 10) and control (n = 10) groups. The rats in the treatment group received energy drinks and distilled water alternatively on a daily basis for 10 h and 14 h liberally for 30 days while the control group received distilled water liberally for the 30 days. The weight of the rats were measured daily during the period of the study. The rats were sacrificed by cervical dislocation on the 31st day of the experiment, and the brain was carefully dissected out, weighed using Mettler Toledo weighing balance. The values obtained from the control and treatment groups were recorded and compared statistically using the unpaired sample t-test and symmetric measured test of the statistical package for social sciences. **Results:** The results of this experiment indicated that there was a significant ($P < 0.05$) increase in the body and brain weights (g), and a significant ($P < 0.05$) decrease in relative brain weight (%) of the treated animals with energy drinks as compared to the control group. Conclusion: Long-term consumption of energy drinks could, therefore, have adverse effects on the body and brain weights of adult Wistar rats. **Recommendation:** We suggest that further studies aimed at corroborating these observations in humans be carried out.

Key words: Body, brain, energy drinks, weight, Wistar rats

INTRODUCTION

Energy drinks are types of beverage containing stimulant drugs, chiefly caffeine which are marketed as providing mental or physical stimulation. They may or may not be carbonated, and generally contain large amounts of caffeine and other stimulants, and may also contain sugar or other sweeteners, herbal extracts and amino acids (Howard and Marczinski, 2010). They are subsets of the larger group of energy products, which includes bars and gels (Howard and Marczinski, 2010). Energy drinks could also be described as flavored beverages containing high amounts of caffeine and typically other additives, such as Vitamins, taurine, herbal supplements, creatine, sugar, and guarana, a plant product containing concentrated caffeine. The energy drinks are sold in cans and bottles, and are readily available in grocery stores, vending machines, convenience stores, bars and other venues where alcoholic drinks are sold. Adolescents, particularly males, consume the most, with per-consumer consumption in these groups reaching almost a liter/day. Soft drinks contribute up to 10% of energy intake in adolescents (Lee, 2009). A number of personal, social, cultural and environmental factors are associated with

Address for correspondence:
Dr. Josiah Obaghwarhievwo Adjene,
Department of Medical Laboratory Science, Achievers University,
Owo, Ondo State, Nigeria.
E-mail: joadjene@yahoo.com

Access this article online	
Quick Response Code:	Website: www.jecajournal.com
	DOI: 10.4103/1596-2393.142925

increased energy drink consumption, including taste, parental consumption, parenting styles, social status, and cultural background (McCarthy, 2009).

Although, people take these energy drinks to improve energy, weight loss, stamina, athletic performance, and concentration (Lee, 2009; McCarthy, 2009), consumption of energy drinks have been said to lead to rising public health problem because medical and behavioral consequences can result from excessive caffeine (which is a content of the drinks) intake (McCarthy, 2009). A growing body of scientific evidence has documented some harmful health effects of energy drinks in man (Seifert *et al*., 2011).

There are many brands and varieties of energy drinks (Howard and Marczinski, 2010). Acesulfame and Aspartame are sweeteners used in energy drinks. Acesulfame has been described as a zero-calorie sweetener that is 200 times sweeter than sugar. It works in the body by stimulating the secretion of insulin and can produce various health disorders that include mental confusion, visual disturbances, headache and depression (Leden, 2012). Aspartame is composed of 40% aspartic acid, 50% phenylalanine and 10% methanol (Sadowska, 2012). The methanol is later converted to formaldehyde and formate in many tissues. Formic acid is the principal metabolites responsible for the deleterious effects of acute intoxication by methanol in humans and animals (Butchko *et al*., 2002). It causes blindness and loss of hepatic function (Trocho *et al*., 1988). The recent population-based San Antonio Heart Study suggested that artificial base sweeteners such as aspartame and acesulfame consumption might be fueling the obesity epidemic instead of fighting it (Fowler *et al*., 2008). Caffeine in energy drinks can cause the excretion of water from the body to dilute high concentrations of sugar entering the blood stream, leading to dehydration (Temple, 2009).

Findings from short-term feeding trials in adults also support an induction of positive energy balance and weight gain by intake of sugar-sweetened sodas, but these trials are few (Vasanti *et al*., 2006). The weight of epidemiologic and experimental evidence indicates that a greater consumption of Sweetener is associated with weight gain and obesity (Vasanti *et al*., 2006). The benefits of reducing soft and energy drink consumption include reduced overweight and obesity, reduced risk of some chronic diseases and improved dental health (Leden, 2012).

Haven known the various benefits and some consequences of energy drinks consumption, It would, therefore, be worthwhile to examine the effects of long-term consumption of energy drinks on the body and brain weights of adult Wistar rats.

MATERIALS AND METHODS

Experimental Animals

The Ethical Committee of the Achievers University, Owo granted the approval before the commencement of this research. Twenty adult Wistar rats with an average weight of 200 g were obtained and maintained in the Animal Holding of the Department of Medical Laboratory Science, College of Natural and Applied Sciences, Achievers University, Owo, Ondo State, Nigeria. The rats were randomly assigned into two groups: A and B (n = 10). Group A served as a treatment group while Group B served as control. The animals were fed with grower's mash obtained from Edo Feeds and Flour Mill Limited, Ewu, Edo State, Nigeria liberally during the period of this research.

Energy Drinks Consumption

The energy drinks were obtained from retailer stores in Owo, Ondo State, Nigeria. The rats in the treated group received energy drinks and distilled water alternatively on a daily basis for 10 h and 14 h liberally in 30 days, while the control group received distilled water liberally for the 30 days in line with an improved method of (Adjene *et al.,* 2010) and the weight of the rats were taken daily. The ingredients contained in the energy drinks (bullet) were as follows: Water, citric acid, carbon dioxide, taurine (0.38%), acidity regulator (sodium citrate), sweeteners (acesulfame and aspartame), flavoring, caffeine (31.5 mg), glucoronolactone (0.01%), nicotinamide (7.92 mg/100 ml, 49.5% RDA) Color ammonia caramel, inositol, niacin, pantothenic acid (33% RDA, about 1.98/100 ml), Vitamin B6 (143% RDA about 2 mg/100 ml) Vitamin B12 (80% RDA, 2 ug/100 ml). The rats were sacrificed through cervical dislocation on the 31st day of the experiment, and the brain of each animal was extracted, weighed and recorded using Mettler Toledo weighing balance. The values obtained from the control and treatment groups were recorded and compared statistically using the unpaired sample t test and symmetric measured test of the Statistical Package for Social Sciences (SPSS 20).

RESULTS

The findings of the experiment revealed that there was a significant ($P < 0.05$) increase in the body and brain weights (g), and a significant ($P < 0.05$) decrease in relative brain weight (%) of the animals treated with energy drinks as compared to the control animals [Table 1 and Figures 1-4].

DISCUSSION

The results of this experiment indicated that there was a significant ($P < 0.05$) increase in the body and brain weights (g), and a significant ($P < 0.05$) decrease in the relative weight (%) of the brain of the treated animals

with energy drinks as compared to the control group. It could, therefore, be inferred from the study that a prolonged consumption of energy drinks accounted for a significant increase in body and brain weights (g) of the treated animals with energy drinks. It is probable that the result obtained could be due to the sleeplessness effects of the caffeine component of the energy drinks as proposed by (Howard and Marczinski, 2010). The significant weight gain reported in this study could also be due to the high rate of catabolism caused by the effects of high availability of insulin induced by the sweetening constituents of the energy drinks thereby causing an increase in the rate of lipid storage in the adipose tissues (Vasanti *et al.*, 2006). This supports an existing hypothesis that an increase in sweeteners consumption can be associated with increased risk of weight gain (Malik *et al*., 2010) because of decreased satiety and incomplete compensatory reduction in energy intake (Bray, 2007; Anton *et al*., 2010). This work is also in line with the suggestion by population-based San Antonio Heart Study group (2008), that artificial sweeteners consumption as seen in energy drinks might be fueling overweight and obesity epidemic instead of fighting it (Fowler *et al*., 2008; Vasanti *et al.*, 2006).

Table 1: The mean±SEM weight (g) and relative weight (%) of the brain of the animals

Parameters	Group of animals	
	Control (n_1=10)	Treated (n_2=10)
Body weight (g)	197.43±7.549*	217.86±5.515*
Brain weight (g)	1.649±0.0272*	1.790±0.0346*
Relative brain weight (%)	0.8719±0.0230*	0.8279±0.0256*

*Significant (P<0.05). SEM - Standard error of the mean

The significant ($P < 0.05$) increase in brain weight observed in this study could have resulted in swellings of the brain parenchyma based on the neurotoxic effects of the energy drinks on the cells of the brain. Under such conditions, there is a net shift of water from the extracellular space to the interior of the brain cells (Johanson, 1995). Cytotoxic edema usually involves intracellular swelling of glial, endothelia and neurons (Johanson, 1995). Regulation

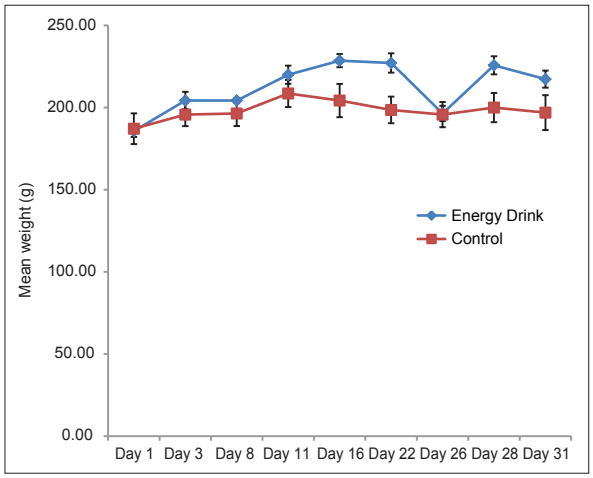

Figure 1: Line chart showing the daily mean body weights (g) of the animals

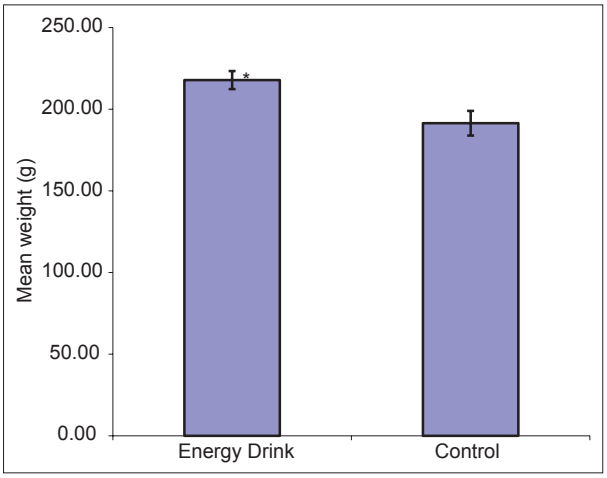

Figure 2: Bar chart showing the mean body weight (g) of the animals (*Significant ($P < 0.05$)

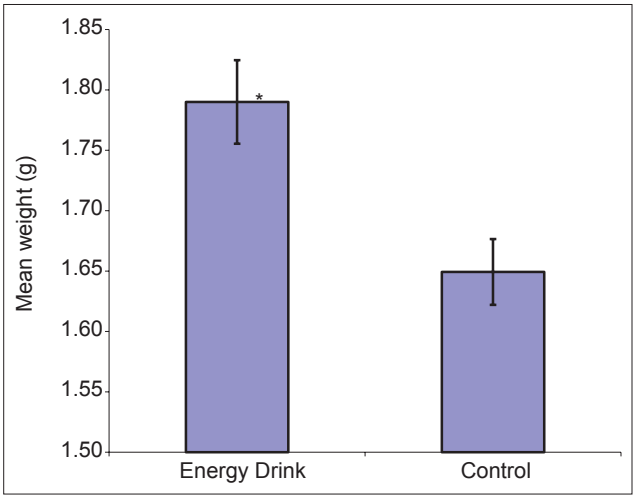

Figure 3: Bar chart showing the mean brain weight (g) of the animals (*Significant ($P < 0.05$)

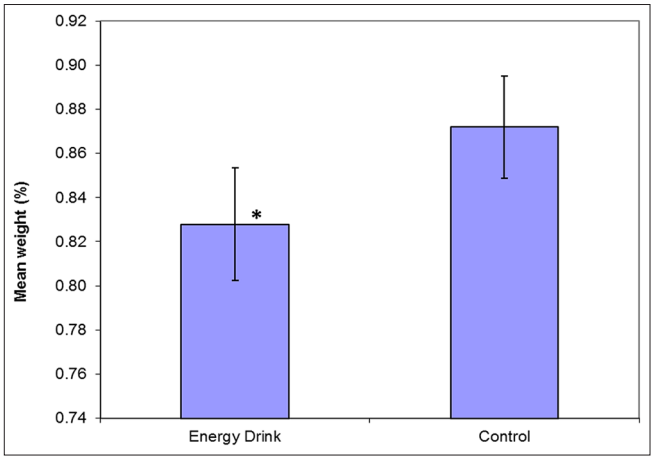

Figure 4: Effect of Energy drinks on relative body weight (%) in Wistar rats (*Significant ($P < 0.05$)

of brain water content and therefore of the volume is critical for maintaining the intracranial pressure within tolerable limits (Johanson, 1995). In this study, energy drinks could have acted as toxins to the cells of the brain thus affecting their cellular integrity and causing a defect in membrane permeability and cell volume homeostasis (Johanson, 1995). As brain tissue swells or shrinks, the activity of the cellular transporters is approximately modified by the up or down regulations as reported in the case of hyponatremia or hypernatremia (Johanson, 1995). Ischemia or pharmacologic disruption of cellular transporters can cause swelling of parenchyma of the brain. However, there are many different causes of cell swelling or shrinkage, including drug poisoning, water intoxication, hypoxia, and acute hyponatremia (Johanson, 1995). Brain swellings can lead to severe cytotoxic edema and may lead to marked reduction in the size of the ventricular system and basal cisterns (Johanson, 1995).

Beside the aspartame content of energy drinks being an excitoneurotoxic agent (Potenza and el-Mallakh, 1989), caffeine may be a potential danger in the development of several diseases, with some medical implications. It has been reported previously that chronic administration of efavirenz to an adult Wistar rats resulted in a significant ($P < 0.05$) decrease in weight of the body and brain and a significant increase ($P < 0.05$) in the weight and relative weight of the inferior colliculus as compared to the control group (Adjene and Onwumelu, 2009; Adjene and Arukwe, 2009). This report advances further the vulnerability of the brain to long-term consumption of energy drinks. Since energy drinks has an excitoneurotoxic and excitotoxin effects that help in the breaking down of the blood brain barrier (Butchko, *et al*., 2002), it is probable that the results obtained in this experiment may have been due to the neurotoxic effect of energy drinks on the neuronal cells of the brain of adult Wistar rats. This report suggests an evidence of the possibility of microanatomical damage to the brain of adult Wistar rat. Therefore, we recommend histological and biochemical studies as an adjunct study to corroborate these observation.

CONCLUSION AND RECOMMENDATION

The study revealed that long-term consumption of energy drinks could cause a significant ($P < 0.05$) increase in body and brain weights and a significant ($P < 0.05$) decrease in relative brain weight (%) of adult Wistar rats. We suggest further studies aimed at corroborating these observations in humans.

REFERENCES

1. Adjene J.O., Arukwe F.I. (2009). Effects of chronic administration of efavirenz on the brain and inferior colliculus weights of adult wistar rats. Rev Electron Biomed/Electron J Biomed 3:36-40.
2. Adjene J.O., Ezeoke J.C., Nwose E.U. (2010). Histological effects of chronic consumption of soda pop drinks on kidney of adult wistar rats. North Am J Med Sci 2 (1): 215-7
3. Adjene J.O., Onwumelu P. (2009). Effects of chronic administration of efavirenz on the body and brain weights of adult wistar rats. J Exp Clin Anat 8 (1):13-6.
4. Anton S.D., Martin C.K, Han H., Coulon S., Cefalu W.T., Geiselman P, *et al*. (2010). Effects of stevia, aspartame, and sucrose on food intake, satiety, and postprandial glucose and insulin levels. Appetite 55 (1):37-43.
5. Bray G.A. (2007). How bad is fructose? Am J Clin Nutr 86 (4):895-6.
6. Butchko H.H., Stargel W.W., Comer C.P., Mayhew D.A., Benninger C., Blackburn G.L, *et al*. (2002). Aspartame: Review of Safety Regul. Toxicol Pharmacol 35 (2 pt 2):S1-93.
7. Fagherazzi G., Alice V., Daniela S.S., Martin L., Beverley B., Françoise C. (2013). Consumption of artificially and sugar-sweetened beverages and incident type 2 diabetes. Nationale–European Prospective Investigation into Cancer and Nutrition cohort. Am J Clin Nutr 97 (3):517-523.
8. Fowler S.P., Williams K., Resendez R.G., Hunt K.J., Hazuda H.P., Stern M.P. (2008). Fueling the obesity epidemic? Artificially sweetened beverage use and long-term weight gain. Obesity (Silver Spring) 16 (8):1894-1900.
9. Howard M.A., Marczinski C.A. (2010). Acute effects of a glucose energy drink on behavioral control. Exp Clin Psychopharmacol 18 (6): 553-61.
10. Johanson C.E. (1995). Effects of Fluid in Balances. Neuroscience in Medicine. P. Michael conn, J.B. Lippincott Company, p. 187-189.
11. Leden E. (2012). Artificial Sweetener: Food Ingreedience Like aspartame should Be avoided to Stay Healthy. Available from: http:/www.policymic.com/mobile/articles/16014/Artificial-sweetener-whyyou-should completely-avoid-them.[Last accessed on 2013 Nov 24].
12. Lee J. (2009). Energy drinks vs. sports drinks: Know thy difference. Available from: http://www.speedendurance.com/2009/07/09energy-drinks-vs-sports-drinks-know-thy difference. [Last accessed on 2011 Jan 17].
13. Malik V.S., Hu F.B. (2012). Sweeteners and risk of obesity and type 2 diabetes: The role of sugar-sweetened beverages. Curr Diab Rep [Epub ahead of print].
14. Malik V.S., Popkin B.M., Bray G.A., Despres J.P., Willett W.C, Hu F.B. (2010). Sugar-sweetened beverages and risk of metabolic syndrome and type 2 diabetes: A meta-analysis. Diabetes Care 33 (11):2477-83.
15. McCarthy M. (2009). Overuse of energy drinks worries health pros. Available from: http://www. usatoday.com/sports/2009-07-01-Drinks_N.htm. [Last accessed on 2011 Jan 17].
16. Potenza D.P., el-Mallakh R.S. (1989). Aspartame: Clinical update. Conn Med 53 (7):395-400.
17. Sadowska J. (2012). Evaluation of the effect of consuming an energy drink on the concentration of glucose and triacylglycerols and on fatty tissue deposition. A model study. Acta Sci Pol Technol Aliment 11 (3):311-8.
18. Seifert S.M., Schaechter J.L., Hershorin E.R., Lipshultz. (2011). Health effects of energy drinks on children, adolescents, and young adults. Pediatrics 127 (3):511-28.
19. Temple J.L. (2009). Caffeine use in children: What we know, what we have left to learn and why we should worry. Neurosci Biobehav Rev 33 (6):793-806.
20. Trocho C., Pardo R., Rafecas I., Virgili J., Remesar X., Fernandez-Lopes J.A. (1988). Formadehyde derived from dietary Aspartame binds to tissue components *in vivo*. Life Sci 63 (5); 337-49.
21. Vasanti S.M., Matthias B.S, Frank B.H. (2006). Intake of sugar-sweetened beverages and weight gain: A systematic review1,2,3. Am J Clin Nutr 84 (2):274-88.

How to cite this article: Adjene JO, Emojevwe V, Idiapho DE. Effects of long-term consumption of energy drinks on the body and brain weights of adult Wistar rats. J Exp Clin Anat 2014;13:17-20.

Source of Support: Nil, **Conflict of Interest:** None declared.