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Original Article

Effect of Cola and Energy Drink Consumption on Blood Glucose Levels of Non-Obese and Obese Medical Students

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ABSTRACT

Objective: To compare blood glucose levels, prior and later to cola/energy drink consumption, between non-obese and obese individuals and to correlate them with anthropometric indices of obesity.

Study Design: Quasi-Experimental study.

Place and Duration of Study: Nishtar Medical University-Multan, from Aug 2023 and Feb 2024.

Methodology: A total of 108 medical students were categorized as non-obese males (NOMs), non-obese females (NOFs), obese males (OMs) and obese females (OFs), with each of four groups having 27 individuals, whose adiposity and fasting glycemic status was assessed as-per World-Health-Organization standards. To observe effect of cola drink on post-prandial glycemic index, 250 ml of Cola Drink was administered to all study groups in a fasting status while same quantity of Energy Drink was used to observe effect of energy-drink at another occasion.

Results: 108 subjects were assessed. Though fasting glucose level of NOMs and NOFs pre-cola/energy-drink1 intake were not significantly different from obese participants, glucose levels later to cola/energy drink intake were significantly different [(p=0.000, p=0.000) and (p=0.000, p=0.000) respectively] with energy drink leading to more marked post-prandial hyperglycemia within obese subjects. Post-cola and energy drink glucose levels within OMs and OFs showed a significant positive correlation with both BMI and WHR [(r=0.394, p=0.042), (r=0.470, p=0.013) and (r=0.404, p=0.037), (r=0.496, p=0.008)] and [(r=0.433, p=0.024), (r=0.496, p=0.009) and (r=0.469, p=0.014), (r=0.507, p=0.007)].

Conclusion: Energy drinks induce marked post-prandial hyperglycemia predominantly in obese individuals.

Keywords: Beverages; Body Mass Index; Cola Drink; Energy Drink; Hyperglycemia; Medical Students; Obesity; Waist Hip Ratio.

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INTRODUCTION

Cola drinks are sweetened carbonated beverages whose each 100 mL provides an overall energy value of 42 kcal while energy drinks on the other hand extend an overall energy content of 60 Kcal. Globally, there has been a gradual rise in the annual expenditure on carbonated and/or energy drinks with Pakistan witnessing a substantial expenditure of 110 Billion PKR solely on the purchase of these beverages in 2021.[1] This escalating consumption poses a significant threat to the well-being of individuals by becoming a harbinger of the most prevalent syndrome of modern society - obesity.

A systemic analysis of the Global Burden of Disease study 2013 showed that 27.9% of Pakistani men and 38.4% of Pakistani women above the age of 20 were obese when measured in terms of BMI (≥25 kg/m²).[2] As per the 2019 statistics extended by world obesity federation, Pakistan ranks tenth out of 188 countries in terms of obesity with 50% of the population being obese or overweight while latest statistics by the World Obesity Federation project that by 2030, 5.4 million of school-aged children will be obese.[3]

With consumption of sweetened beverages glucose levels can rise acutely,[4] whose normalization takes place via GLUT 4 dynamics.[5] Consumption of cola drinks by non-obese healthy individuals stimulates HMP pathway associated de-novo lipogenesis,[6] an effect more pronounced with energy drink consumption. Moreover, when obese people consume cola and/or energy drinks, the deleterious effects mentioned before are quadrupled because of obesity associated enhanced secretion of inflammatory cytokines e.g IL-6 and TNF-alpha 14.[7] These cytokines interfere with the insulin signaling pathways and lead to compensatory hyperinsulinemia which later affects glucose metabolism via modulation of GLUT-4, insulin receptors and key enzymes of glycolysis.[8] This

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in turn becomes the base for atherogenic and metabolic disorders.[9]

This study was conducted with the aim to gather scientific data showing deleterious effects of cola drinks and energy drinks on blood glucose levels of healthy young adults, in order to provide an insight to clinicians and parents about the dangers associated with consumption of these drinks

METHODOLOGY

After gaining an approval of the Institutional Review Board of Nishtar Medical University Multan (via letter number: 3192), the study was carried out at various medical institutes of the town between the months of August 2023 and February 2024.

The sample size of 108, 27 subjects for each of the four study groups, was calculated with power of 90% and an alpha value of 5% by inserting in the mean differences of fasting blood glucose levels between non-obese and obese adults,[10] in the formula 7.4b3 of the software "Sample size determination in health studies – a practical manual (version 2.0.21) issued by WHO Geneva".

Inclusion Criteria: By utilizing the WHO 2000 and 2015 criteria of obesity for south Asians, which states that South Asians irrespective of gender with a BMI of >25 kg/m2 while males with a WHR of >0.9 and females with a WHR of >0.89 are considered obese,[11] a general pool of ethnicity matched non-obese and obese medical students with ages between 18-24 was identified where every subject was considered a potential candidate for this research. All of the potential subjects were then screened for an undetected hypertensive and/or diabetic status at two different occasions two weeks apart prior to final selection of the study population as per WHO guidelines, which states that subjects with BP 140/90 mmHg,[12] and FBG of 126 mg/dL,[13] are considered hypertensive and diabetics respectively.

Exclusion Criteria: All those subjects who turned out to be carrying an undetected hypertensive and/or diabetic status at one and/or both of the screening occasions were included.

Exclsuion Criteria: Those with a family history of genetic obesity as well as endometabolic disorders as well as those with a history of exogenous steroids and/or recreational drug intake were excluded from the study.

Since our primary aim was to compare the FBG of non-obese medical students as well as their adequacy of glucose tolerance with their age and ethnicity matched obese counterparts, hence we randomly started to place the subjects from within our general pool of obese and non-obese medical students into four categories i.e. non-obese males (NOMs - Group-A), non-obese females (NOFs Group-B), obese males (OMs - Group-C) and obese females (OFs - Group-D) as per inclusion criteria described earlier till each of the groups had 27 individuals.

The study subjects were informed that they would be contacted a week before the day fixed for first and second stem of experimental protocols which in case of their non-availability would be adjusted accordingly. Once the day of first as well as second observation was set, every study participant was called 3 days prior to estimation of the first and second observation and was instructed to eat an unrestricted diet containing at least 150g of carbohydrates per day for the next 3 days and to start observing an overnight fast from 10 pm onwards the night preceding the day set for both first and second observations. After ensuring that every study subject had followed the dietary as well as fasting protocols in most literal terms on the mornings of both experimental occasions, FBG levels of every subject were estimated later to which they were served standard portions (250 mL) of Coca Cola and Sting at first and second experimental occasions respectively. Once the subjects had consumed coca cola/sting, they were made to sit in a well-conditioned comfortable environment for the next two hours with the advice to stay within the fixed experimental premises observing the instructions of limiting physical activity and avoidance from smoking/eating/drinking. After which their post-prandial glucose levels were analyzed on both of the experimental occasions.

To record both fasting as well as postprandial glucose levels Accu Chek Performa glucometer was used which, while working on the principle of mutant variant of the quino protein glucose dehydrogenase (Mut. Q-GDH),[14] gives results comparable to those extended by other commonly used laboratory techniques within a confidence interval of 95%,[15] has an accuracy of 100% for blood glucose levels <100 mg/dL and 99% for blood glucose levels >100 mg/dL with an established sensitivity of 81%.[16]

The data analyzed using IBM's Statistical Package For Social Science (SPSS) version-25, where its normality distribution was assessed via Shapiro-Wilk's and Kolmogorov Smirnov's tests. Since

majority of study variables were normally distributed, ANOVA in association with Post-hoc Tukey's test was used to deduce the existence of differences among fasting as well as postprandial glucose levels of various study groups while Pearson's correlation was applied to correlate quantitative variables with each other.

RESULTS

Since majority of our study parameters were normally distributed, hence study variables have been represented as Mean±SD. It was noted that NOMs had a BMI (20.92±1.58) and WHR (0.83±0.03) while NOFs had a BMI (20.41±1.75) and WHR (0.76±0.02). OMs on the other hand had a BMI (28.93±2.72) and WHR (0.91±0.01) while OFs had a BMI (28.30±3.01) and WHR (0.84±0.04).

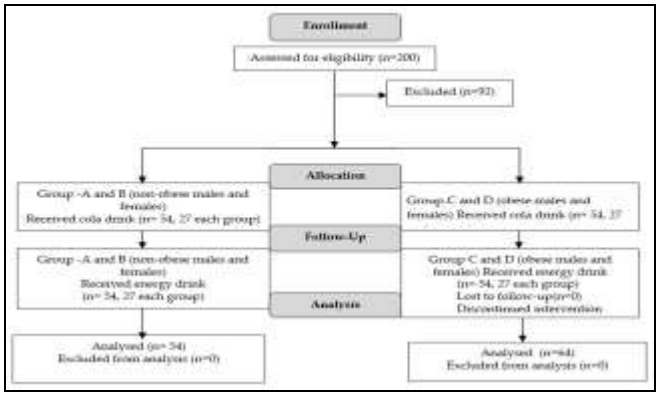

Figure-1: Patient Flow Diagram (n= 108)

NOMs and NOFs did not have a FBGs, both prior to cola and energy drink consumption, different from their obese counterparts [(p=0.599, p=0.924) and (p=0.372, 0.988) respectively]. This data has been represented in Table-I. Blood glucose levels of both OMs and OFs 2 hours later to intake of both cola and energy drinks however were significantly higher as compared to their non-obese counterparts [(p=0.000, p=0.000) and (p=0.000, p=0.000) respectively]. This comparative analysis has been given in Table-I and Table-II.

It was noted that FBGs did not have any significant correlation with both BMI and WHR in all the study groups i.e. NOMs, NOFs, OMs and OFs (Table-III). However, glucose levels of NOMs, NOFs, OMS and OFs showed a significant positive correlation with BMI later to both cola and energy drink intake (Table-IV). Also, within NOMs, NOFs, OMs and OFs, glucose levels later to both cola and energy drink intake showed a significant positive correlation with WHR also (Table-IV).

Table-I: Fasting Blood Glucose Levels Of Study Groups Prior To Cola/Energy-Drink Intake

Variables	Groups in comparison (n=27 for each group)		p-value
Fasting Blood Glucose (mg/dl) (Pre-Cola Drink Intake)	NOMs 88.55±3.34	NOFs 89.44±3.32	0.786
	OMs 89.74±3.59	OFs 90.03±3.70	0.989
	NOMs 88.55±3.34	OMs 89.74±3.59	0.599
	NOFs 89.44±3.32	OFs 90.03±3.70	0.924
Fasting Blood Glucose (mg/dl) (Pre-Energy Drink Intake)	NOMs 88.62±2.46	NOFs 89.33±3.02	0.868
	OMs 90.11±4.07	OFS 89.62±3.63	0.952
	NOMs 88.62±2.46	OMs 90.11±4.07	0.372
	NOFs 89.33±3.02	OFs 89.62±3.63	0.988

Table-II: Fasting Blood Glucose Levels Of Study Groups Prior To Cola/Energy-Drink Intake

Variables	Groups in comparison (n=27 for each group)		p-value
Blood Glucose (mg/dl) (Post-Cola Drink Intake)	NOMs 99.29±1,65	NOFs 100.81±2.16	0.055
	OMs 111.66±2.46	OFS 110.96±2.29	0.633
	NOMs 99.29±1,65	OMs 111.66±2.46	0.000
	NOFs 100.81±2.16	OFs 110.96±2.29	0.000
Blood Glucose (mg/dl) (Post-Energy Drink Intake)	NOMs 102.22±1.52	NOFs 105.40±1.86	0.000
	OMs 116.33±1.90	OFS 117.77±1.71	0.017
	NOMs 102.22±1.52	OMs 116.33±1.90	0.000
	NOFs 105.40±1.86	OFs 116.33±1.90	0.000

DISCUSSION

We observed that though the FBGs of NOMs and NOFs were not significantly different from their obese counterparts, 2 hours post cola drink consumption glucose levels of OMs and OFs were markedly higher than those of NOMs and NOFs respectively. This observation of ours is in accordance with that of a contemporary study,[17] and could be explained on the basis of physiological reasoning which states that obesity associated disruption of GLUT signaling confers the prelude for poor tolerance of glucose surge

and hinders its normalization within two hours of the intake of a glucose bolus in form of a cola drink even (p<0.001) which found that males had slightly higher fasting serum glucose levels than females. This

Table-III: Correlation Of Post Cola/Energy Drink Glucose Levels With BMI and WHR Within Non-Obese Participants

Pearson's Correlation	Post-Cola Drink Intake Glucose Levels				Post-Energy Drink Intake Glucose Levels			
	NOMs		NOFs		NOMs		NOFs	
	r	*p*-value	r	*p*-value	r	*p*-value	r	*p*-value
BMI	0.311	0.114	0.336	0.087	0.338	0.085	0.440	0.021
WHR	0.469	0.014	0.450	0.019	0.466	0.014	0.496	0.009

Table-IV: Correlation Of Post Cola/Energy Drink Glucose Levels With BMI and WHR Within Obese Participants

Pearson's Correlation	Post-Cola Drink Intake Glucose Levels				Post-Energy Drink Intake Glucose Levels			
	OMs		OFs		OMs		OFs	
	r	*p*-value	r	*p*-value	r	*p*-value	r	*p*-value
BMI	0.394	0.042	0.404	0.037	0.433	0.024	0.469	0.014
WHR	0.470	0.013	0.496	0.008	0.496	0.009	0.507	0.007

in apparently healthy obese young adults.[18]

Our data also showed that the serum glucose levels 2 hours later to energy drink consumption were higher than those measured 2 hours after the consumption of cola drink in all the study groups, with OMs and OFs having more marked glycemic derangement than NOMs and NOFs. This, too, is mirrored by a contemporary study,[19] and could be due to much higher sugar content of energy drinks. Moreover, since obese people are already likely to harbor a borderline hyperglycemic status due to obesity associated proinflammatory changes, hence ingestion of energy drinks poses further hindrances to normalization of their glucose levels even after 2 hours of their consumption and thus pushes them towards a prediabetic status. These results, however are in contrast with another study (p<0.05) which showed that serum glucose levels 2 hours later to consumption of cola drink were higher than those calculated 2 hours post energy drink consumption. This disparity though could be explained given the fact that the study was conducted on albino rats,[20]

Our results also revealed that both NOFs and OFs exhibit higher serum glucose levels, 2 hours later to consumption of both cola and energy drinks in comparison to OMs and NOMs. Gender-specific variations in body composition and adiposity can explain these results. Females tend to possess a higher proportion of body fat, particularly within the abdominal region, as compared to males, which is strongly associated with insulin resistance and impaired glucose metabolism. The confluence of heightened adiposity and the consumption of energy and soft drinks synergistically heighten the risk of glucose intolerance among females.[21] This result, however, has been contrasted by another study contrast might be because of the population consisting of an entirely different ethnicity with different patterns of obesity and different age group.[22]

Some studies have been trying to correlate anthropometric parameters of obesity (such as BMI and WHR) with poor glucose tolerance.[23] Our results provide robust evidence that there is a direct correlation between these anthropometric parameters and poor glucose tolerance. Elevated BMI, indicative of increased adiposity, often leads to heightened insulin resistance exacerbated by obesity associated dysregulation of adipocytokines which in turn impede glucose uptake by cells and hence hinder the post-cola and energy drink normalization of glucose levels.[24]

Additionally we observed that, NOMs showed a positive correlation of their post-cola/energy drink intake glucose levels with BMI only while NOFs showed such a correlation with both BMI and WHR. Moreover OMS and OFs showed a positive correlation of their post cola/energy drink intake glucose levels with both BMI and WHR with correlations being steeper in obese diaspora. This fact is also in coherence with the results of certain studies conducted in south Asian populations which do state that south Asians develop endo-metabolic derangements more frequently with changes of WHR instead of BMI because of genetic differences in fat distribution.[25]

LIMITATIONS OF STUDY

Since obesity itself leads to production of several inflammatory cytokines as well as adipokines our study did not take into account their plasma levels into account specifically within the obese diaspora of our study. Moreover, It was a single observation based study and hence we do recommend cohort studies in this very important homeostatic domain for future researchers so that additional

data could be gathered for national policy making regarding healthy lifestyles and food choices.

CONCLUSION

On the basis of our results we thus conclude that both cola and energy drinks hinder the normalization of glucose levels 2 hours later to their ingestion with energy drinks causing a status similar to a pre-diabetic state specifically within the obese individuals even in younger ages.

Outcome and Utilization: on the basis of above crafted facts it could be advocated to the responsible positions of our society to take steps for limitation of both cola and energy drink ingestion, specifically by the youth, so that the burden of obesity associated endo-metabolic disorders like diabetes could be prevented in the long run.

Conflict of Interest: None

Funding Disclosure: None

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

HH & MAM: Data acquisition, data analysis, critical review, approval of the final version to be published.

MSN & AK: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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