

Original Research Article

Relationship between intake of artificial sweeteners and body mass index in young non-diabetic adults: a cross-sectional study

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ABSTRACT

Background: Artificial sweeteners have skyrocketed the market in the last decade and there are unlimited products available today that contain them. They are often projected as one of the easy and effortless method of cutting down calories and have gained importance in the community. They are being used as one of the dietary tools to control or prevent weight gain not only in diabetic adults but also in young healthy adults and children. There is a need to examine any possible contribution of these substances on body weight and BMI of an individual.

Methods: A cross sectional study was conducted among randomly selected healthy non-diabetic subjects of both sexes in the age group 18-35 years. Those with history of intake of artificial sweeteners in the last one year (in the form of pellets or diet soda) were considered as study group and equal no of non-users were taken as comparison group for study purpose. A pretested semi structured questionnaire prepared in English language was used to collect information. Variables such as height, weight and body mass index were noted. Data was analyzed using SPSS (version 20.0).

Results: There was a statistically significant difference between the two groups in terms of weight and BMI ($p=0.003$ and 0.002 respectively). The mean weight and BMI was more in those subjects who had consumed more than one serving of diet can per day. Sweeteners in pellet form failed to show any statistical significance association between frequency of use and BMI.

Conclusions: The study suggested of a possible association between the use of artificial sweeteners and BMI. Young adults need to be sensitized about various safe weight management techniques and healthy lifestyle, rather than resorting to methods like intake of artificial sweeteners.

Keywords: Artificial sweeteners, Body mass index, Obesity, Overweight

INTRODUCTION

Artificial sweeteners are generally synthetically produced substances that provide a sweet taste like sugar while containing negligible food energy. Replacing sugar with artificial sweeteners can be a helpful tool to reduce energy intake and body weight and thereby reducing the risk for diabetes and cardiovascular disease.¹ Considering

the prevailing increase in the epidemic of obesity (BMI>30) affecting children as well as adults worldwide, the use of artificial sweeteners in food and beverages [pellets/diet soft drinks (diet can)] are gaining popularity because many believe that they are an easy way to reduce or maintain weight as they provide sweet taste without the extra energy derived from food and drinks containing sugar.² The last decade saw an increase in the number of

food products containing non-caloric artificial sweeteners. A rise in the percentage of population who are obese coincides with an increase in the widespread use of non-caloric artificial sweeteners especially as diet coke and in food products especially beverages.³ There are conflicting reports about their health benefits especially on weight control. Some studies show that regular consumption of these sweeteners reduce the intake of calories and promote weight loss, some show no effect and many research works show a positive correlation between use of artificial sweeteners and increase in weight and/or BMI.⁴ Increase in the injudicious use of artificial sweeteners and considering the prevailing rise in obesity the present study was undertaken to examine any possible contribution of these substances on body weight and BMI of an individual. The following null hypotheses were tested:

- There is no significant difference in BMI among those taking artificial sweeteners and those not taking it.
- The frequency of servings of different forms of sweetener consumption has no effect on BMI.

METHODS

Design overview

A cross sectional study was conducted in the hospital settings of a tertiary care hospital.

Study subjects

100 non-diabetic subjects of both sexes, in the age group between 18-35 years were randomly selected from among the attendants of the patients admitted in the general medicine ward of the institution, hospital staff and medical students. Those with history of intake of artificial sweeteners were considered as study group (categorized as users) and participants reporting no artificial sweetener use were categorised as 'nonusers'. Equal number of non-users were taken as comparison group for study purpose. The purpose of the study was explained to each subject and from those willing to participate a written consent was taken.

Collection of data

A pretested, semi structured questionnaire was given to the subjects. The subjects were allowed to respond in their own time. The questionnaire was prepared in English language. To prevent recall bias, history of intake of sweeteners in the last one year was considered. History regarding demographic profile, personal history, dietary history, history of weight gain in the last one year, frequency of intake of artificial sweeteners (pellets and dietary soda), any method to lose weight in the last one year (dieting/strict diet intake as per dietician, any medication to lose weight), details of physical activity and any significant past medical history were enquired.

The reported physical activity was categorised as: a) light- physically very easy, sitting office work, e.g. secretarial work; b) moderate- work including standing and walking, e.g. store assistant, light industrial work; c) active- work including walking and lifting, or heavy manual labour, e.g. industrial work, farm work.⁵

Dietary assessment

Beverages have been identified as major source of artificial sweetener in the diet and consumption is increasing in children and young adults.^{6,7} Hence estimates of artificial sweetener consumption in the study were quantified from items listing 'diet soft drinks (diet soda) and use of pellets in beverages (tea/coffee/milk). Other beverages were not included in the study because of their low frequency of consumption. Intake of artificial sweeteners consumption was assessed by food frequency questionnaire at baseline.⁸ Participants reporting diet soft drink use were asked cans (300 ml) of soft drink/day and weekly doses calculated accordingly. Similarly, consumption of number of pellets in cups of tea/coffee/milk per day and in a week was calculated.

Frequency response options for pellets and diet soda were noted as:

- Never
- <1serving/week
- >1/week and <1day
- >1/day

Examination

The participants were then subjected to height and weight measurement and BMI was calculated. Weight and height were measured using standard methodology as per WHO guidelines.⁹

For measuring weight the weighing machine was placed on leveled ground and needle adjusted to zero mark the subject was made to stand erect in the centre of the platform with minimum clothing and bare foot, hands at the side and looking straight forward, weighing machine was regularly standardized and weight was recorded to the closest of kilogram.

Height was measured to the nearest of 1cm. The subject was made to stand erect, barefoot with heel, buttock, shoulders and back of head touching the wall while marking highest point of vertex on the wall making sure that subject stands comfortably facing front with lower border of orbit in the same horizontal plane as that of external auditory meatus.

Body mass index

Weight in kg and height in cms were measured using standard methodology as per WHO guidelines. Body mass index (Quetelet index) was calculated using formula

BMI = $Wt(kg)/Ht(m^2)$ and ≥ 30 was interpreted as obese.¹⁰

Exclusion criteria

Subjects with history of impaired glucose tolerance, diabetes mellitus, abnormal lipid profile, thyroid disorders, metabolic disorders and steroid intake were excluded from the study.

Statistical analysis

The information collected was compiled, tabulated and analysed. Descriptive statistics were used for the demographic profile of subjects and anthropometric measurements and summarized as mean \pm standard deviation (SD). Independent sample t test performed for continuous data to find the significance of difference for means of various measures. The difference in mean intake of sweeteners by different modes and frequency of

servings was assessed using ANOVA test. Pearson's chi-square test was performed for categorical data to find the association between different mode of sweetener intake and weight gain. A p value of less than 0.05 ($p < 0.05$) was considered statistically significant. Analysis was performed using computer software SPSS (20.0)

RESULTS

A total of 50 persons who reported taking artificial sweeteners in one or the other form were included in the study and for these equal number of subjects were taken as the comparison group. There was male predominance showing 28 and 30 males respectively in study and comparison group with the male:female ratio being 1.27:1 among the study group and 1.5:1 in the comparison group. In the study group 20 (40%) persons were in the age group of 25-30 years whereas 23 (46%) of the persons in the comparison group were in the age group of 30-35 years.

Table 1: Difference in Mean \pm SD of various parameters among study and comparison group using independent sample t test.

Parameter	Study group Mean \pm SD	Comparison group Mean \pm SD	t	p
Age	28.58 \pm 4.71	29.36 \pm 4.69	-0.829	0.409
Weight	69.50 \pm 9.95	63.92 \pm 7.92	3.12	0.003*
Height	1.64 \pm 0.09	1.67 \pm 0.10	-1.36	0.177
BMI	25.17 \pm 4.65	22.8 \pm 2.64	3.10	0.002*

($p < 0.05$ *significant).

Table 2: Difference in various parameters among three groups of cases (based on frequency of servings) consuming Diet can using ANOVA.

Parameter	Frequency of servings			f-value	Significance
	<1/week, N=16	>1/week<1/day, N=19	>1/day, N=7		
Weight	65.75 \pm 10.81	71.84 \pm 9.67	76.28 \pm 6.82	3.28	0.047*
Height	1.64 \pm .114	1.66 \pm .073	1.63 \pm .079	0.39	0.678
BMI	22.80 \pm 6.05	25.94 \pm 3.68	28.61 \pm 2.46	4.32	0.020*

($p < 0.05$ * significant).

Table 1 shows that mean age and height of non-users was slightly more as compared to the users but this difference was not statistically significant whereas there was a statistically significant difference between the two groups in terms of weight and BMI ($p = 0.003$ and 0.002 respectively).

On an average, almost equal number of participants in two groups were engaged in different levels of physical activity.

Among 42 subjects who gave history of intake of Diet can, 7 (16.66%) reported having consumed more than 1 serving of "diet can" per day. Out of the total 33 subjects

who reported consuming pellets, 5 subjects (15.15%) had consumed more than one serving of pellets per day. A significant no of subjects (50%) reported consuming both diet can and pellets, thereby indicating that those who consume artificial sweeteners are not restricted to just one mode of intake.

Table 2 shows that among 42 cases had consumed diet can (alone or in combination with pellets) the mean weight and BMI was more in those subjects who had consumed more than 1 serving of diet can per day. The difference in weight and BMI among three groups was statistically significant ($p = 0.047$ and 0.020 respectively).

Table 3 shows that for 33 cases who consumed pellets (alone or in combination with diet can), as the no of servings increase the mean weight and BMI also showed an increase Although BMI failed to show any statistical significance.

Table 4 depicts that among the users, out of 28 persons who had history of weight gain 19 (67.85%) had consumed sweeteners in both diet can and pellets, 5 (17.85%) only diet can and 4 (14.28%) only pellets. There was a statistically significant association ($p=0.010$) between mode of sweetener intake and weight gain.

Table 3: Difference in various parameters among three groups of cases (based on frequency of servings) consuming Pellets using ANOVA.

Parameter	frequency of servings			f-value	significance
	<1/week, N=12	>1/week<1/day, N=16	>1/day, N=5		
Weight	65.41±7.8	74.87±5.0	85.80±3.19	21.65	0.000*
Height	1.60±0.085	1.68±0.070	1.72±0.080	5.65	0.008
BMI	25.17±2.77	26.54±2.96	29.04±3.15	3.12	0.058

($p<0.05$ * significant).

Table 4: Association of history of weight gain in the last one year and intake of sweeteners by different modes using chi-square test.

Mode of intake of sweetener	Weight gain present Number (%)	Weight gain absent Number (%)	Total Number (%)
Diet can only	5 (17.85)	12 (54.54)	17 (34.00)
Pellets only	4 (14.28)	4 (18.18)	8 (16.00)
Both	19 (67.85)	6 (27.27)	25 (50.00)
	28 (100)	22 (100)	50 (100)

$\chi^2=9.05$, $p=0.010$.

DISCUSSION

The prevalence of obesity and overweight is steadily increasing and is a major health problem both in developed and developing countries. Obesity can be defined as a condition where there is an excess of body fat. BMI is an important anthropometric parameter to assess the amount of tissue mass (muscle, fat and bone) an individual and can be used to screen for weight categories.¹¹ Consumption of artificial sweeteners has gained popularity and is a common strategy for facilitating weight control. For adults trying to wean themselves from sugar and sugary soda, the use of artificial sweetener is a possible short term substitute. The present study was undertaken to assess the use of artificial sweeteners in weight management and its effect on BMI. All subjects in the study were non-diabetic. The results showed that both the null hypothesis was refuted, although it was accepted in case of frequency of intake of pellets and BMI.

After adjusting for common factors that contribute to weight loss such as dieting, exercise, the study showed that those who take more of artificial sweeteners have higher BMI. This could be attributed to over consumption of other food and beverages that may occur in conjunction with artificial sweetener consumption owing to overestimation of the number of calories saved by

substituting diet beverages for sugar sweetened beverages.¹² Apart from sugar the remaining calories derived from protein or fat.¹³ The present study is in harmony with Stellmann SD et al who reported more weight gain in users of artificial sweeteners than nonusers over one year period.¹⁴ Fowler et al have also reported that, among participants who were normal weight or overweight at baseline, risk of weight gain and obesity were significantly greater in those consuming Artificially sweetened beverages (ASB) compared with those who did not consume ASB.¹⁵ Blum et al observed that increase diet soda consumption was positively correlated/associated with increase BMI after two years.¹⁶ Similar results were also reported by Berkey et al who examined relationship between BMI and diet soda consumption over the course of one year.¹⁷ On the contrary, Rogers et al have found beneficial effect on weight with use of artificial sweeteners.¹⁸ The health benefits of artificial sweeteners are inconclusive, with research showing mixed findings.

The study is of cross-sectional design so it was not possible to reach conclusion regarding the cause and outcome. BMI was used as a marker of obesity rather than direct measurement of fat amount (by computerized tomography). The findings may not be generalized as few subjects were studied.

CONCLUSION

The present findings are suggestive of possible association between increased artificial sweetener intake and BMI. But causality is far from established. Counselling services and education programmes for awareness, healthy dietary habits and exercise for weight management need to be inculcated in health programmes.

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