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Chocolate consumption and its relation to risk of type 2 diabetes mellitus

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ABSTRACT

Background: There is a substantial interest in the potential role of chocolate consumption and its association with the risk of type 2 diabetes mellitus. The objective of this study was to examine the association of consumption of chocolate with the risk of type 2 diabetes mellitus.

Methods: A case control study was conducted at PSG Hospitals between 1st June 2017 and 1st July 2017. All those who had newly diagnosed type 2 diabetes and attended Department of Endocrinology for follow-up visit were the cases and the relatives accompanying them without the history of diabetes were the controls. Chocolate consumption and other dietary factors were elicited. The mediating factors studied were age, sex, Body Mass Index (BMI), educational levels, smoking status, alcohol consumption, family history of diabetes, potassium intake, magnesium intake and use of statins.

Results: After adjusting the potential confounders, chocolate consumption was inversely associated with risk of type 2 diabetes (p<0.05) with odds ratio of 0.564 (95% CI = 0.32 - 0.98).

Conclusions: Our findings suggest that moderate consumption of chocolates (preferably 1 to 2) per week has a decreased risk of type 2 diabetes mellitus. Potential applications of this knowledge include recommendations by health care professionals to encourage individuals to consume a wide range of phytochemical rich foods include chocolates in moderate amounts. The results from our study also suggest that adjusting for mediating factors did not alter the results and hence other unknown factors may explain inverse relation between chocolate consumption and type 2 diabetes mellitus.

Keywords: Chocolate consumption, Potassium intake, Type 2 diabetes mellitus, Tea consumption

INTRODUCTION

There is a substantial interest in the potential role of chocolate and one of its primary bioactive compounds, flaven-3-ols in prevention and management of cardio vascular disease (CVD).¹⁻⁵ Few randomized controlled

clinical trials (RCT) have examined mechanisms by which chocolate in cocoa and flaven-3-ols potentially reduce CVD risk.⁶⁻¹⁰ However, the predominant focus of these studies has been blood pressure effects and many of these studies examined its effects on systolic and diastolic blood pressure, LDL and HDL cholesterol. In addition,

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some of these RCT's reported a reciprocal relation between insulin resistance and chocolate consumption.

There were few observational studies which supported the association between cocoa intakes and reduced diabetes risk. Chocolate contains caffeine, flavonoids and minerals such as magnesium that could influence the risk of diabetes mellitus. An inverse association between the consumption of caffeine, flavonoids and magnesium with the role of diabetes mellitus has been reported with inconsistent results. 11-12 In contrast, cocoa and chocolate have beneficial effects in insulin resistance, oxidative stress and inflammation which play important roles in pathogenesis of diabetes mellitus. However, it is still unclear, whether chocolate consumption is associated with risk of diabetes mellitus and whether this association differs according to the characteristics of the study population. The present study is aimed to find the association between chocolate consumption and risk of diabetes mellitus.

METHODS

Study population and design

A case-control study was conducted at PSG Hospitals. All those who have newly diagnosed in the past 1 year as type 2 diabetes and attending the Department of Endocrinology for follow up between 1stJune 2017 and 1st July 2017 were considered as cases. Controls were those who accompany with them and do not have history of diabetes. We then retrospectively evaluated their food practices and other demographic information.

General assessments

The general assessment survey was conducted at the outpatient Department of Endocrinology, PSG Hospitals, Coimbatore. The general questionnaire contained questions on demographic characteristics. Body weight

(in kg) and height (in meter) were also measured. However, in few cases, we were not able to measure height. Food intake was assessed using a validated Food Frequency Questionnaire in this population and from this magnesium intake and potassium intake were estimated. The questionnaire also asked about chocolate consumption, coffee intake, tea intake, smoking status, practice of alcohol intake, whether previously diagnosed as diabetes, other medical histories and medications taken.

Statistical analysis

To examine the association between chocolate consumption and incidence of type 2 diabetes, we used four logistic regression models. In the first model, odds ratio and 95% confidence intervals for type 2 diabetes mellitus were calculated against a reference group of low consumers of chocolate adjusted for age (continuous) and gender (male/female).

A second logistic regression model corrected the other known diabetes risk factors include smoking status (present/absent), BMI, education attainment (classes up to 12th standard/college and above), family history of diabetes (present/absent); alcohol intake (gm. per week). Body mass index was calculated by the formula, body weight (kg) divided by the square of the body height (meter). A third model corrected for coffee and tea consumption. Mediating factors were included in the final model. The mediating factors considered were daily intake of magnesium and potassium which were elicited from their food consumption practices and the effects of long term medications like the use of statins.

RESULTS

The study included 150 cases and 150 controls. Demographic characteristics of the study participants among cases and controls were presented in Table 1.

Table 1: Distribution of the participant's demographic characteristics.

Variables	Cases No. (%) or Mean ± SD	Controls No. (%) or Mean ± SD	p Value
Age (years, continuous)	53.29 ± 11.52	41.75 ± 12.44	p < 0.05
BMI (kg/m², continuous)	26.12 ± 5.09	25.99 ± 5.21	0.824
Potassium (mg/day)	624.11 ± 151.14	661.14 ± 209.54	p < 0.001
Magnesium (mg/day)	134.27 ± 50.19	123.30 ± 44.96	0.082
Sex			0.246
Male	72 (48%)	62 (41.3%)	
Female	78 (52.0%)	88 (58.7%)	
Educational levels			p < 0.001
Up to 12 th Standard	108 (72.0%)	85 (56.7%)	
College and above	42 (28.0%)	65 (43.3%)	
Current smoking status			0.569
Yes	17 (11.3%)	14 (9.3%)	
No	133 (88.7%)	136 (90.7%)	
Alcohol intake			0.427
rarely/moderately	144 (96.0%)	141 (94.0%)	

weekly/daily	6 (4.0%)	9 (6.0%)	
Family history of diabe	tes		p < 0.001
Yes	91 (60.7%)	51 (34.0%)	
No	59 (39.3%)	99 (66.0%)	
Use of statins			0.317
Yes	1 (0.7%)	0 (0.0%)	
No	149 (99.3%)	150 (100%)	

Table 2: Chocolate consumption and its association with type 2 diabetes.

Category	Cases $(N = 150)$		Controls $(N = 150)$		
	Number	Percentage	Number	Percentage	Total
Do not take on a weekly basis	131	87.3%	102	68%	233
1-2 chocolates per week	17	11.3%	38	25.3%	55
3-4 chocolates per week	1	0.7%	5	3.3%	6
≥5 chocolates per week	1	0.7%	5	3.3%	6

Table 3: Chocolate consumption and the risk for type 2 diabetes in the multivariate analyses.

	Model 1 adjusted for age and sex	Model 2 adjusted for BMI, education, smoking, alcohol and family history of diabetes in addition to variables in Model 1	Model 3 adjusted for coffee and tea consumption in addition to variables in Model 2	Model 4 adjusted for potassium, magnesium and statins in addition to variables in Model 3
Odds ratio	0.559	0.601	0.540	0.564
95% CI for diabetes	0.336 - 0.932	0.352 - 1.026	0.312 - 0.936	0.324 - 0.980
p Value	0.026	0.062	0.028	0.042

Among the variables studied, all differences between case subjects and control subjects were comparable except for age, educational level and family history of diabetes. Cases were slightly older in age compared to controls. The mean and standard deviation of age (years) among cases were 53.29 ± 11.52 and that of controls were 41.75 ± 12.44 . This difference was statistically significant (p < 0.05).

The mean and standard deviation of potassium intake among cases were 624.11 ± 151.14 and that of controls were 661.14 ± 209.54 . This difference was statistically significant (p < 0.001). 72% of the participants among diabetic were having education up to 12th standard whereas the similar value for non-diabetic was only 56.7%. This difference was statistically significant (p < 0.001). Among diabetic, 60.7% of them had family history of diabetes whereas the similar value for non-diabetic was only 34.0%. This difference was statistically significant (p < 0.001).

87.3% of the cases do not take chocolate on a weekly basis whereas the similar value for controls was only 68%. 11.3% of the cases take 1 to 2 chocolates on a weekly basis whereas the similar value for controls was 25.3 % (Table 2). In the multivariate regression model (Table 3), it was observed that the participants who consume more chocolate had a significantly decreased

risk of diabetes compared with those who do not take chocolate on a weekly basis (odds ratio = 0.564, 95% CI = 0.324 - 0.980).

DISCUSSION

In our study, self-reported chocolate intake was significantly inversely associated with diabetes mellitus. Many studies supported our findings that chocolate consumption may lower risk of diabetes mellitus. The recent Maine- Syracuse Longitudinal Study (MSLS) reported that persons who eat chocolate at least once a week have a lower prevalence of diabetes and are at lower risk for a diagnosis of diabetes for five years later. 14

Beneficial effects of cocoa and chocolate on risk factors related to diabetes mellitus were reported in short term randomized clinical trials as well as long term experimental studies5,8. It was reported in same studies that cocoa or chocolate improves insulin resistance, oxidative stress and inflammation. However, whether these results are the possible mechanisms resulting in an inverse association between chocolate consumption and risk of diabetes is still unclear. It is also uncertain that which substance in chocolate is responsible for the inverse association with diabetes mellitus that we have observed.

However, it is important to differentiate between the natural product cocoa and the processed product chocolate which is an energy dense food. In addition, physical activities, diet and other life style factors must be carefully balanced to avoid differential weight gain over time.

Our study has several limitations. Since this was a case-control study, cause and effect relations between chocolate consumption and diabetes cannot be established. This has not been established in any study in the literature also. A bidirectional relationship could not be ruled out, modest amounts of chocolate protect against diabetes but some diabetic patients chose to eat modest amounts of chocolates.

It is also unclear if the benefits of the chocolates are limited only to dark chocolate. It is widely hypothesized that cocoa flavonols, found in larger amounts in dark chocolate, responsible for its health benefits and more large scale prospective studies are required to provide more information on whether only dark chocolate is beneficial or chocolate in general is beneficial. It is also possible that chocolate consumption may represent an overall marker for a cluster of favorable socio demographic profiles and thereby healthier life style behaviors and better health status. This could explain, at least in part, the observed associations with the insulin biomarkers.

CONCLUSION

Study findings suggest that moderate consumption of chocolates (preferably 1 to 2) per week has a decreased risk of type 2 diabetes. Potential approach of this knowledge includes recommendations by health care professionals to encourage individuals to consume a wide range of phytochemical rich foods include chocolates in moderate amounts.

The results from our study also suggest that adjusting for mediating factors did not alter the results and hence other unknown factors may explain inverse relation between chocolate consumption and type 2 diabetes mellitus. Continued studies are necessary to study the role of specific factors regarding the association of chocolate consumption and type 2 diabetes mellitus.

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