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ORIGINAL RESEARCH

Chocolate intake is associated with a lower body mass index in adult men and women in transitional Albania

Iris Mone[1,2], Bledar Kraja[1,2], Jolanda Hyska[1], Genc Burazeri[1,3]

[1] University of Medicine, Tirana, Albania;

[2] University Hospital Center Mother Theresa, Tirana, Albania;

[3] Department of International Health, School for Public Health and Primary Care (CAPHRI), Faculty of Health, Medicine and Life Sciences, Maastricht University, Maastricht, The Netherlands.

Corresponding author: Iris Mone, MD, PhD
Address: Rr. "Dibrës", No. 371, Tirana, Albania
Telephone: +355692149301; E-mail: iris_mone@yahoo.com

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Abstract

Aim: In light of the controversial evidence regarding health effects of chocolate intake, we aimed to assess its association with body mass index (BMI) among adult individuals in Albania, a transitional post-communist country in South Eastern Europe which has traditionally employed a Mediterranean dietary pattern.

Methods: A cross-sectional study was conducted in 2003-2006 involving a population-based sample of 737 Tirana residents aged 35-74 years (469 men, 268 women; overall response: 70%). Of these, 565 individuals (373 men and 192 women) provided data on chocolate intake and anthropometrics (77% of the sample). A 105-item food frequency questionnaire, including chocolate consumption, was administered to all individuals. Nine categories were used to assess the average frequency of intake of each food item in the past 12 months. In the analysis, chocolate intake was dichotomized into: consumption of <1/month vs. ≥1/month. A physical examination included measurement of weight and height. Furthermore, information on socio-demographic characteristics and classical risk factors was collected. Multivariable-adjusted general linear model was used to calculate the mean BMI values by chocolate intake groupings.

Results: Upon simultaneous adjustment for socio-demographic characteristics, classical risk factors and nutritional factors, there was an inverse association between BMI and chocolate intake in both sexes (sex-pooled mean BMI: 26.1 among participants who consumed chocolate <1/month vs. 27.0 in those with an intake of ≥1/month; P<0.001).

Conclusions: This study points to a beneficial effect of moderate chocolate intake on lowering BMI, which deserves further vigorous investigation and replication in prospective studies in Albania and other populations.

Keywords: Albania, body mass index, chocolate, cross-sectional study, epidemiology.

Introduction

Chocolate is a typical sweet food that evokes ambivalent feelings: pleasure as the result of its taste, flavor and appearance, and concerns as the results of its content with high sugar and calorie (1). Therefore, previous epidemiological studies have observed healthy and unhealthy effects of chocolate intake.

Several studies have reported a positive link between frequent chocolate intake and a lower body mass index (BMI) (2,3), or a reduction in the risk of cardio-metabolic disorders (4) and diabetes (5). Furthermore, chocolate consumption has been linked to beneficial effects on human health and diseases (6) including cardiovascular health (7,8) blood pressure and vascular function (9).

However, a cross-sectional study reported a positive association between chocolate intake and BMI in a dose-response pattern (10). Hence, according to this report, the positive relationship between chocolate intake and a lower body mass was evident only among participants with preexisting serious obesity-related illness (10). Also, a meta-analysis of 10 observational studies concluded that the evidences on the association between chocolate intake and CVD risk need to be confirm in further studies (11).

In light of the controversial evidence regarding health effects of chocolate intake, we aimed to assess its association with BMI among adult individuals of both sexes in Albania, a transitional post-communist country in South Eastern Europe which has traditionally employed a Mediterranean dietary pattern.

Methods

A cross-sectional study involving a representative sample of 35-74-year-old residents of Tirana, the Albanian capital, was conducted in 2003-2006 (12).

Study population and sampling

The sample consisted of an age-and-sex-stratified random sample from the adult population of the Tirana municipality, as registered in the Albanian census of April 2001. We sampled a total of 1200 individuals, 720 men and 480 women (12). Of the estimated 1046 subjects (644 men and 402 women) who met the eligibility criteria (12), 737 individuals participated in the study (469 men, 268 women; overall response: 70%).

Data collection

A semi-quantitative food frequency questionnaire (FFQ), consisting of 105 food items including chocolate consumption, was administered to all individuals (13). Participants were asked to indicate how often, on average, they had eaten specified amounts of each food item in the past 12 months. Nine categories were used to assess the average frequency of intake of each food item: <1/month, 1-3/month, 1/week, 2-4/week, 5-6/week, 1/day, 2-3/day, 4-5/day, and >6/day. In the analysis, chocolate intake was dichotomized into: consumption of <1/month vs. ≥1/month.

Microdiet, Version 2 (Downlee Systems Limited, UK, 2005) was employed to calculate for each food item the daily calorie intake. The respective values for all 105 food items were added up in order to get a summary score for each participant (13) for the total daily calorie intake expressed in Kcal, protein, fat and carbohydrate (in the analysis, all expressed as percentage of total calorie intake) and SFA, MUFA, PUFA and trans fatty acid intake (in the analysis, all expressed as g/daily calories*100).

In addition, information on socio-demographic characteristics (age and educational level) and classical risk factors (physical exercise and alcohol intake) was collected for each participant. Furthermore, a physical examination included measurement of weight and height (based on which we calculated the

body mass index [BMI]: kg/m^2) and waist and hip circumferences (based on which we calculated the waist-to-hip ratio [W/H]) (12). The study was approved by the Albanian Committee of Medical Ethics. Participants gave written consent after being informed about the aims and procedures of the study.

Statistical analysis

The statistical analysis included 565 individuals (373 men and 192 women) for whom data on chocolate intake and anthropometric measurements were available (565/737=77% of the overall sample of study participants).

General linear model was used to assess the association between chocolate consumption and socio-demographic characteristics (age and education) and behavioral factors (exercise, alcohol intake, BMI, W/H and nutrients), separately in men and women. Age-adjusted mean values and their respective 95% confidence intervals (95%CIs) were calculated for each covariate by the two categories of chocolate intake (<1/month vs. ≥1/month). Subsequently, multivariable-adjusted (footnote to Table 2) mean BMI values and their respective 95%CIs were calculated by the two categories of chocolate intake (<1/month vs. ≥1/month), separately in men and women. SPSS (Statistical Package for Social Sciences, version 19.0), was used for all the statistical analyses.

Results

Mean age was significantly higher among women who reported chocolate intake at least once per month compared with their counterparts who consumed chocolate <1/month (56 years vs. 50 years, respectively; P<0.001) – a finding which was not evident in men (Table 1, upper panel). Mean educational level was not significantly different between the two groups distinguished by frequency of chocolate intake in either sex. A similar finding was evident for alcohol intake, notwithstanding the particularly low consumption of alcohol among women. Conversely, in both sexes, participants who reported chocolate consumption of ≥1/month were more physically active than individuals who reported a chocolate intake of <1/month (in men: 201 kcal vs. 87 kcal, respectively, P<0.001; in women: 164 kcal vs. 95 kcal, respectively, P<0.001). Furthermore, mean BMI was considerably lower among participants who consumed chocolate ≥1/month than those who consumed chocolate <1/month (in men: 26 vs. 28, respectively, P<0.001; in women: 25 vs. 27, respectively; P<0.001). In men only, mean W/H was significantly lower among participants who reported a chocolate intake ≥1/month compared with individuals who consumed chocolate <1/month (0.93 vs. 0.95, respectively; P<0.001).

In both sexes, the total calorie intake was significantly higher among individuals who consumed chocolate ≥1/month than those who consumed chocolate <1/month (Table 1, lower panel). In men only, a higher chocolate intake was related to a lower protein (as percentage of total calories), whereas in women only a higher chocolate consumption was associated with higher total fats. In men, a higher chocolate intake was related to higher total carbohydrates, whereas in women there was evidence of the opposite. In both sexes, PUFA level (g/daily calories) was significantly higher among participants who consumed chocolate ≥1/month than those who consumed chocolate <1/month. In women only, MUFA level was higher in participants with a higher chocolate consumption. On the other hand, in men only, there was evidence of a higher level of trans fatty acids in those who consumed chocolate ≥1/month compared to those who consumed chocolate <1/month.

Table 1. Association of chocolate intake with socio-demographic characteristics, conventional risk factors and nutrient intake in a population-based sample of Albanian adults; age-adjusted mean values from general linear models

Upper panel: Socio-demographic and classical risk factors	Men (N=373)				Women (N=192)			
	N*	Mean	95%CI	P	N*	Mean	95%CI	P
Age (years):								
<1/month	146	52.1	50.5-53.7	0.742	74	55.7	53.3-58.0	<0.001
≥1/month	227	51.8	50.5-53.1		118	50.0	48.2-51.9	
Education (years):								
<1/month	146	11.8	11.3-12.4	0.060	72	10.9	10.1-11.8	0.514
≥1/month	226	11.2	10.7-11.6		118	10.6	9.9-11.2	
Alcohol intake (drinks/week):								
<1/month	146	3.6	2.4-4.8	0.320	73	0.8	0.2-1.3	0.657
≥1/month	226	4.4	3.4-5.4		118	0.6	0.2-1.1	
Physical exercise (kcal):								
<1/month	146	86.8	69.5-104.1	<0.001	71	94.7	76.1-113.4	<0.001
≥1/month	225	201.5	187.5-215.4		117	164.4	150.0-178.7	
BMI:								
<1/month	146	28.0	27.5-28.5	<0.001	74	27.1	26.3-27.9	<0.001
≥1/month	226	25.8	25.4-26.2		118	24.7	24.0-25.3	
W/H:								
<1/month	146	0.95	0.94-0.95	<0.001	74	0.87	0.86-0.88	0.139
≥1/month	226	0.93	0.92-0.94		118	0.86	0.85-0.87	
Lower panel: Nutrients	**Men**				**Women**			
	N*	**Mean**	**95%CI**	**P**	**N**	**Mean**	**95%CI**	**P**
Total calorie intake (kcal):								
<1/month	146	2909	2824-2996	<0.001	74	2431	2333-2529	<0.001
≥1/month	227	3186	3117-3255		118	2711	2634-2788	
Total proteins (% of calories):								
<1/month	146	17.9	17.6-18.2	<0.001	74	17.7	17.4-18.0	0.670
≥1/month	227	16.8	16.6-17.1		118	17.6	17.4-17.9	
Total fats (% of calories):								
<1/month	147	35.1	34.5-35.6	0.281	74	38.3	37.6-39.0	0.001
≥1/month	227	35.5	35.0-35.9		118	39.8	39.3-40.4	
Total carbohydrates (% of calories):				0.053				0.013
<1/month	146	47.4	46.8-48.1		74	46.1	45.3-46.9	
≥1/month	227	48.2	47.7-48.7		118	44.7	44.1-45.4	
SFA (g/daily calories*100):								
<1/month	146	1.34	1.32-1.36	0.231	74	1.43	1.40-1.46	0.038
≥1/month	227	1.32	1.30-1.34		118	1.47	1.45-1.49	
MUFA (g/daily calories*100):								
<1/month	146	1.48	1.45-1.51	0.395	74	1.65	1.60-1.69	0.018
≥1/month	227	1.50	1.48-1.52		118	1.71	1.68-1.75	
PUFA (g/daily calories*100):								
<1/month	146	0.76	0.74-0.78	<0.001	74	0.86	0.83-0.90	0.002
≥1/month	227	0.83	0.81-0.85		118	0.94	0.91-0.96	
Trans (g/daily calories*100):								
<1/month	146	0.022	0.021-0.023	0.003	74	0.025	0.024-0.027	0.378
≥1/month	227	0.024	0.023-0.025		118	0.025	0.023-0.026	

* Discrepancies in the totals are due to missing covariate values.

In crude/unadjusted models (Table 2, model 1), mean BMI was substantially lower among participants who consumed chocolate ≥1/month compared to those who consumed chocolate <1/month (sex-pooled mean BMI: 25.3 vs. 27.5, respectively; P<0.001). Adjustment for age (model 2) did not affect the findings (sex-pooled mean BMI: 25.2 vs. 27.5, respectively; P<0.001).

Table 2. Association of chocolate intake with BMI; unadjusted and multivariable-adjusted mean BMI values by sex

Model	Men (N=373)			Women (N=192)			Overall (N=565)*		
	Mean	95%CI	P	Mean	95%CI	P	Mean	95%CI	P
Model 1†:									
<1/month	27.98	27.47-28.49	<0.001	26.94	26.12-27.76	<0.001	27.46	27.02-27.91	<0.001
≥1/month	25.79	25.38-26.21		24.77	24.12-25.42		25.28	24.92-25.64	
Model 2‡:									
<1/month	27.99	27.48-28.50	<0.001	27.10	26.27-27.94	<0.001	27.52	27.08-27.97	<0.001
≥1/month	25.79	25.38-26.20		24.67	24.02-25.33		25.23	24.89-25.61	
Model 3¶:									
<1/month	27.00	26.58-27.42	0.046	26.47	25.83-27.11	<0.001	27.04	26.66-27.41	<0.001
≥1/month	26.41	26.08-26.74		24.86	24.39-25.34		26.13	25.84-26.43	

* Adjusted for sex.

† Model 1: crude/unadjusted models.

‡ Model 2: adjusted for age.

¶ Model 3: adjusted for age, education, exercise, alcohol intake and W/H, total calorie intake, protein, fat and carbohydrate (all expressed as percentage of total calorie intake) and SFA, MUFA, PUFA and trans fatty acid intake (all expressed as g/daily calories*100).

Upon simultaneous adjustment for all covariates (model 3), the inverse association between BMI and chocolate intake was attenuated but nevertheless remained statistically significant in both sexes (sex-pooled mean BMI: 26.1 vs. 27.0, respectively; P<0.001).

Discussion

We found a strong inverse relationship between frequency of chocolate intake and BMI, which was consistent in both sexes and persisted upon adjustment for a wide array of socio-demographic characteristics and behavioral factors including nutrient intake as assessed by a detailed FFQ.

The results of the present study are comparable with a previous study conducted by Golomb et al. (2), which examined the cross-sectional relationship of chocolate intake and BMI among American adults. They reported that chocolate consumption frequency is linked to lower BMI in unadjusted model (P=0.008) and in adjusted models adding age, sex, activity, saturated fats, fruit and vegeta-

bles, mood and calories (P=0.001). Also, another study found that high chocolate consumption was associated with lower BMI, body fat and waist circumference in young people regardless of different confounders (age, sex, total energy, saturated fats, fruit and vegetable, and physical activity) (3).

One possible explanation for these findings is due to the fact that the caloric components as well as the other biologically active components of the food could influence BMI. Hence, the observed inverse association between chocolate consumption and BMI may relate to the effects of other biologically active components of chocolate such as flavanols including catechin, epicatechin, and procyanidins which have a variety of beneficial physiologic actions (6).

Flovanols promote the release of nitric oxide which has been shown to increase oxidation of fatty acids and glucose in skeletal muscle, inhibits fat synthesis in adipose tissue, and stimulates lipolysis in adipocytes (6). The Netherlands Cohort Study after 14 years of follow-up reported that women with the highest dietary intake of total flavonols had significantly lower increases in BMI than women with the lowest intake, over time (0.41 and 0.91, respectively; P<0.05), suggesting a favorable effect of dietary flavanols intake on maintaining of body weight (14). Additionally, animal studies have shown that dietary flovanols intake may possibly reduce weight gain through effects of epicatechin and catechin on target tissues (15,16). Epicatechin improves the mitochondrial content, structure and function as well as capillarity of skeletal muscle (15), whereas catechin increases energy expenditure, decreases fatty acid synthase levels in adipose tissue and inhibits adipocyte differentiation (16).

Another explanation for the observed findings may relate to the effect of chocolate consumption on appetite and satiety. Massolt et al. have shown that chocolate eating and smelling both could reduce appetite (17) whereas in a randomized, controlled study, Tey et al. demonstrated that chocolate consumption could decrease satiety (18). These findings suggest that chocolate consumption may aid for weight maintenance as a result of early termination of food intake.

The main advantages of this study are its community-based design which included men and women from general population of Albania and use of a validated questionnaire for assessment of nutrient intake and physical activity.

The FFQ we used for measurement of dietary patterns was customized to the Albanian context and previously validated in a small sample of Albanian adults of both sexes.

Seemingly, there is no plausible reason to assume differential reporting among participants distinguished by socioeconomic characteristics or BMI groupings. Nevertheless, we cannot entirely exclude the possibility of information bias. Our study has other limitations. The response rate raises the possibility of selection bias. Male non-respondents, in addition to being older than participants, were more likely to be retired; however, exclusion of retirees from the analysis did not affect the magnitude of the association. In women, respondents and non-respondents were more similar. If non-response among thinner individuals was associated with higher chocolate intake, this could attenuate the findings. Conversely, if obese individuals who did not respond tended to employ a higher chocolate consumption, this could spuriously strengthen the findings, but would be unlikely to rule out the entire association. Also, importantly, the data included in this analysis are old.

In conclusion, our findings point to a beneficial effect of moderate chocolate intake on lowering the body mass, which deserves further vigorous investigation and replication in

prospective studies in Albania and other populations.

Conflicts of interest: None declared.

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