chocolate has shown favorable metabolic associations with blood pressure (BP),1-3 insulin sensitivity,4 and cholesterol level.5 Chocolate is rich in antioxidant phytonutrients like catechins that could contribute to favorable relationships of chocolate consumption to insulin sensitivity and BP. However, because chocolate is often consumed as a sweet and bears calories, there are concerns related to its intake.

Body mass index (BMI) is part of the metabolic syndrome (MetS) picture, and other MetS elements relate favorably to moderate chocolate consumption. Therefore, we hypothesized that the benefits of modest frequent chocolate intake might extend to reduced fat deposition, potentially offsetting the added calories. To evaluate this, we examined the cross-sectional relationship of chocolate consumption frequency to BMI.

Methods. Subjects. A total of 1018 men and women aged 20 to 85 years from San Diego, California, without known cardiovascular disease, diabetes, or extremes of low-density lipoprotein cholesterol (LDL-C) levels (115-190 mg/dL inclusive [to convert to millimoles per liter, multiply by 0.0259]), were screenees for participation in a broadly sampling clinical study examining noncardiac effects of statins.4,5 The study protocol was approved by the University of California, San Diego Human Research Protections Program; all participants gave written informed consent.

Measures. To measure chocolate consumption frequency, 1017 subjects responded to the question “How many times a week do you consume chocolate?” Body mass index (calculated as weight in kilograms divided by height in meters squared) was determined for 972 subjects (95.6%), who had both weight and height recorded at the screening visit.

Of the subjects, 975 (95.8%) completed the validated Fred Hutchinson Food Frequency Questionnaire (FFQ). Calories (determined via FFQ) could mediate associations of chocolate with BMI (contravening calorie adjustment): analyses were performed with and without calorie adjustment. Fruit and vegetable intake and saturated fat (safat) intake were assessed for relevance. Fruits and vegetables (linked to lower BMI) bore no relationship to chocolate consumption frequency (β=0.004 [SE=0.007]; P=.55), excluding this as a candidate confounder, but safats (which, however, accompany chocolate via stearic acid) were significantly related both to chocolate intake (β=0.035 [SE=0.005]; P<.001) and higher BMI. Analyses were performed with and without safat adjustment. Amount of chocolate consumed (vs frequency with which it was consumed) was not significantly related to BMI.

Table. Chocolate Consumption Frequency Predicts Lower BMI: Regression Results

<table>
<thead>
<tr>
<th>Adjustment Model</th>
<th>β (SE)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unadjusted</td>
<td>-0.142 (0.053)</td>
<td>.008</td>
</tr>
<tr>
<td>Age and sex</td>
<td>-0.126 (0.053)</td>
<td>.02</td>
</tr>
<tr>
<td>Age, sex, and activity adjusted</td>
<td>-0.130 (0.052)</td>
<td>.01</td>
</tr>
<tr>
<td>Age, sex, activity, and calorie adjusted</td>
<td>-0.146 (0.059)</td>
<td>.01</td>
</tr>
<tr>
<td>Age, sex, activity, safat adjusted</td>
<td>-0.190 (0.059)</td>
<td>.001</td>
</tr>
<tr>
<td>Age, sex, activity, safat, and CES-D adjusted</td>
<td>-0.191 (0.059)</td>
<td>.001</td>
</tr>
<tr>
<td>Age, sex, activity, safat, fruit and vegetable, and CES-D adjusted</td>
<td>-0.201 (0.060)</td>
<td>.001</td>
</tr>
<tr>
<td>Age, sex, activity, safat, fruit and vegetable, and CES-D and calories adjusted</td>
<td>-0.208 (0.060)</td>
<td>.001</td>
</tr>
</tbody>
</table>

Abbreviations: BMI, body mass index; CES-D, Center for Epidemiological Studies Depression scale; safat, saturated fat.

A model containing calories (and activity, as well as age and sex) was included, since calories and activity are usual predictors of BMI. However, calories were otherwise not in adjustment models because chocolate inherently contains calories and adjustment could justly be deemed inappropriate—overstating the benefits of chocolate to BMI. Closely similar results were obtained using an alternate activity measure. Significance was identical for all except the third and fourth models, where significance was stronger (P=.006 and P=.007, vs P=.01 and P=.01).

Association Between More Frequent Chocolate Consumption and Lower Body Mass Index

Hebel, Subhina, and Turchin. Drafting of the manuscript: Hebel. Critical revision of the manuscript for important intellectual content: Hebel, Middleton, Subhina, and Turchin. Statistical analysis: Hebel and Subhina. Administrative, technical, and material support: Hebel and Middleton. Study supervision: Middleton and Turchin.

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1. National Alliance for Health Information Technology. Report to the Office of the National Coordinator for Health Information Technology on defining key health information technology terms [registration required]. http://healthit.hhs.gov/portal/server.pt/gateway/PTARGS_0_10741_848133_0_0_18/10_2


consumed) was also examined. This was determined from the FFQ.

Activity was assessed as how many times per 7-day period the subject engaged in vigorous activity for at least 20 minutes (heart beating rapidly). To evaluate mood, subjects completed the Center for Epidemiological Studies Depression scale (CES-D). Chocolate consumption in this sample was previously associated unfavorably with mood.6 Because mood could serve as a confounder or mediator, analyses were conducted with and without CES-D adjustment.

Statistical Analysis. Univariate summary statistics and bivariate relationships to chocolate and BMI were assessed. Linear regression analysis with standard errors as developed by White7 (heteroskedasticity independent or “robust” standard errors) was used to evaluate chocolate consumption frequency as a predictor of BMI in unadjusted models, in age- and sex-adjusted models, and in models adding adjustment for activity, satfats, and mood. Though the appropriateness of calorie adjustment is debatable (as a variable potentially on the causal pathway to BMI), analyses adjusting for calories were included. Analyses used Stata versions 8.0 and 11.0 (StataCorp). A 2-sided P value of <.05 was considered significant.

Results. The mean (SD) age of the subjects was 57 (12) years and 68% were male, with a mean (SD) BMI of 28 (4.5). Subjects ate chocolate a mean (SD) 2.0 (2.5) times/wk and exercised 3.6 (3.0) times/wk. Chocolate consumption frequency was linked to greater calorie and satfat intake and higher CES-D scores (all P < .001), each relating positively to BMI. Chocolate consumption frequency was not linked to greater activity (P = .97). Yet, greater chocolate consumption frequency was linked to lower BMI (unadjusted, P = .01).

Chocolate preserved its relation to lower BMI with age and sex adjustments (Table)—and indeed, in a range of adjustment models adding activity, calories, satfats, and CES-D score. Calories, satfats, and depression could serve mediating rather than confounding roles. However, chocolate consumption frequency predicted lower BMI with or without such adjustment.

A chocolate consumption frequency–squared term was nonsignificant, providing no evidence for a U-shaped relationship of chocolate consumption frequency to BMI. In contrast to chocolate consumption frequency, the amount of chocolate eaten was not related to BMI, favorably or adversely (eg, per medium chocolate serving of 1 oz [28 g], B = 0.00057 [P = .97] in an age- and sex-adjusted model [analyses not shown]).

Comment. Adults who consumed chocolate more frequently had a lower BMI than those who consumed chocolate less often. The findings were retained or strengthened in a range of adjustment models and was not explained by calorie intake (frequent chocolate intake was linked to more overall calories), activity, or other assessed potential confounders.

The connection of higher chocolate consumption frequency to lower BMI is opposite to associations presumed based on calories alone, but concordant with a growing body of literature suggesting that the character—as well as the quantity—of calories has an impact on MetS factors. Chocolate has shown other metabolic benefits—in prospective observational studies2 and randomized trials—in regard to insulin sensitivity,1 BP,1,2 and total and LDL-C levels.3 (Chocolate has also been linked in prospective observational studies to lower cardiovascular and all-cause mortality; outcomes predicted by MetS elements.) Thus, our findings extend favorable associations of chocolate to metabolic factors.

Chocolate products are often rich in sugar and fat, contributing to assumptions that chocolate boosts BMI. This study does not obviate the possibility that some chocolate-containing products do so, that some chocolate consumption profiles do so, or that for some people, even frequent modest chocolate consumption does so. Moreover, since findings are cross-sectional, causality in the observed association cannot be presumed. However, the finding fits with the literature suggesting benefits of chocolate for other metabolic factors, and we failed to identify a link of chocolate to key BMI-relevant confounders in a direction to explain the finding. Moreover, our findings comport with recent findings from experimental frequent feeding of modest doses of epicatechin from chocolate to rats.8,9 Polyphenols (eg, catechins) in chocolate have antioxidant properties and are candidates to underlie favorable chocolate associations with metabolic factors. Cocoa-derived epicatechin, specifically, is reported to increase mitochondrial biogenesis and capillarity, muscular performance, and lean muscle mass and to reduce weight without changing calories or exercise in rodent studies.8,9 Parallel processes in humans, if present, could underlie our findings.

In conclusion, our findings—that more frequent chocolate intake is linked to lower BMI—are intriguing. They accord with other findings suggesting that diet composition, as well as calorie number, may influence BMI. They comport with reported benefits of chocolate to other elements of MetS. Compatible experimental findings in rats given epicatechin from cocoa suggest the association could be causal. A randomized trial of chocolate for metabolic benefits in humans may be merited.
The authors recommend targeted screening because 17 of 18 cases identified in their study were drawn from “high-risk” populations. Of the newly notified cases in the French national HIV surveillance database in 2009, 28% are heterosexuals of non–sub-Saharan–African origin. Further evidence shows that these “lower-risk” cases are diagnosed as having more advanced HIV illness and that risk-based targeted testing has failed such patients.3

The authors argue that many high-risk cases identified would likely have been identified anyway via diagnostic testing. This contradicts the growing body of literature on the barriers to HIV screening and missed opportunities to test for HIV among high-risk candidates. A number of studies demonstrate that it is hard to implement targeted screening: health care providers lack time and expertise to conduct risk evaluation; patients are inaccurate in reporting their risk status; and targeting injects an anxiety-ridden, stigmatizing tone into the patient-provider discussion that results in low testing rates.3

The authors claim that ED-based detection failed to reveal HIV at earlier stages. They based their assessment on 12 detected cases with available CD4 cell counts. No doubt, these patients seen in an ED setting were sick. But the question of interest is whether they are diagnosed earlier when compared with a targeted screening program. Nothing in the study by d’Almeida et al1 sheds light on that question. Haukoos et al3 compared targeting with routine ED screening. They too reported sick patients, but median CD4 cell counts among cases diagnosed via non-targeted screening (69/µL [interquartile range, 17-430/µL]) were significantly higher than among cases diagnosed via targeted screening (13/µL [interquartile range, 11-15/µL]; P = .02).3

Further studies are needed to understand how to identify patients with undiagnosed HIV infection. We commend d’Almeida et al1 on their findings, which we believe, lend further evidence to the value of expanded and routine rather than targeted HIV testing.

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Trial Registration: clinicaltrials.gov Identifier: NCT00330980

What Is a Modest Public Health Impact?

‘Almeida et al1 evaluated routine human immunodeficiency virus (HIV) screening in 29 emergency departments (EDs). We believe that the results of this study are open to very different interpretations and conclusions:

The authors characterize the observed prevalence of newly diagnosed infections (0.14%) as “low.” Applying this value to all persons aged 18 to 64 years in France translates to 56,000 undetected infections. To put that number in perspective, estimates of 50,000 undetected cases were sufficiently alarming to provoke recommendations on routine HIV screening. Similarly, studies from the United States and France demonstrate that routine HIV screening remains cost-effective at prevalences as low as 0.10%.2

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