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Chocolate-candy consumption and three-year weight gain among postmenopausal U.S. women

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Abstract

OBJECTIVE—To test the hypothesis that greater chocolate-candy intake is associated with more weight gain in postmenopausal women.

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DESIGN AND METHODS—Prospective cohort study involving 107,243 post-menopausal American women aged 50–79 years (mean=60.7) at enrolment in the Women's Health Initiative (WHI), with three-year follow up. Chocolate-candy consumption was assessed by food frequency questionnaire and body weight was measured. Linear mixed models, adjusted for demographic, socio-economic, anthropomorphic and behavioral variables, were used to test our main hypotheses.

RESULTS—Compared to women who ate a 1 oz (~28 g) serving of chocolate candy <1 per month, those who ate this amount 1 per month to <1 per week, 1 per week to < 3 per week and 3 per week showed greater three-year prospective weight gains (kg) of 0.76 (95% CI: 0.66, 0.85), 0.95 (0.84, 1.06) and 1.40 (1.27, 1.53), respectively, (p for linear trend<0.0001). Each additional 1 oz/day was associated with a greater three-year weight gain (kg) of 0.92 (0.80, 1.05). The weight gain in each chocolate-candy intake level increased as BMI increased above the normal range (18.5–25 kg/m^2), and as age decreased.

CONCLUSIONS—Greater chocolate-candy intake was associated with greater prospective weight gain in this cohort of post-menopausal women.

Keywords

Nutrition; chocolate; weight gain; body weight; weight management; women's Health

INTRODUCTION

Obesity remains a major health problem, with women being particularly vulnerable to weight gain during the early postmenopausal years (1). Numerous factors may contribute to weight gain including consumption of energy dense foods such as chocolate (2). While an emerging body of scientific evidence suggests that dark chocolate may have the ability to decrease cardiovascular disease risk over the short-term (3), much is still unknown about the relationship between long-term chocolate-candy consumption and body weight.

In a recent prospective analysis with a six-year follow up in the Atherosclerosis Risk in Communities cohort (ARIC), adult male and female participants who ate 1 oz of chocolate candy at least weekly experienced a mean increase in Body Mass Index (BMI in kg/m^2) of 0.39 (95% confidence interval: 0.23, 0.55) compared to those who ate this amount less often than monthly (2). Conversely, four cross-sectional studies (2, 4–6), which are less rigorous than prospective studies for determining temporality (7), found that chocolate-candy intake was higher among lighter participants, found that chocolate-candy intake was higher among lighter participants. One other cross-sectional study (8) observed a significantly lower body mass index (BMI) and waist circumference among elderly males who preferred chocolate candy than among those who preferred non-chocolate candy.

Given these inconsistent findings, the objective of the current study was to investigate the association between chocolate-candy intake and prospective 3-year weight change in the Women's Health Initiative (WHI), a large sample of racial/ethnically diverse American postmenopausal women. Our primary *a-priori* hypothesis, based primarily on the findings in

the ARIC cohort (2), was that chocolate-candy intake would be positively associated with weight gain.

METHODS AND PROCEDURES

Subjects

The design and methods of the WHI have been described in detail elsewhere (9). In brief, the WHI enrolled 161,808 postmenopausal women 50–79 years of age between 1993–1998 into the OS or four overlapping clinical trials.

Our study included participants from the WHI Observational Study (OS) and Clinical Trial control arms (CT-controls).

Data collection

At baseline (year 0) and year 3 data related to medical history, and health behaviors such as diet, smoking and physical activity were collected. Weight and height were measured during in-clinic visits (see Outcome Variables). Data on physical functioning and psychosocial factors were collected using standardized questionnaires. Information on the standard operating procedures and validity of the baseline measures have been described previously (9–11). A robust set of variables for evaluation as regression-model confounders, which are described below, were collected at year 0 and year 3.

Assessment of Chocolate-candy Intake

Data on chocolate-candy intake were collected at year 0 and 3. This information was collected in the form of responses to a semi-quantitative food-frequency questionnaire (FFQ) designed for the WHI (12). The FFQ contained a single line item asking for the frequency and portion size of "chocolate candy and candy bar" intake over the prior 3 months. Participants were asked to specify their usual serving size as small (1/2 oz), medium (1 oz) or large (1 1/2 oz), and to indicate the frequency of intake as one of nine response options: from never or <1 per month to 2 per day. In order to provide adequate statistical power we converted the original nine categories of chocolate-candy intake frequency into four levels of a 1 oz serving: <1 per month; 1 per month to <1 per 3 weeks; 1 per 3 weeks to <3 per week; and 3 per week. This allowed us to assess and compare temporal changes in body weight during the 3-year period between year 0 and 3 across these four categories. Total chocolate-candy intake, calculated from portion size and frequency of consumption, was used to assess the association between a 1 oz increment in chocolate-candy intake and weight gain during the 3-year period.

Outcome Variable

Body weight was measured at year 0 and 3 by trained and certified personnel using standardized procedures and calibrated beam scales in all WHI participants (9). Our outcome variable, weight change, was calculated as year 3 weight minus year 0 weight.

Statistical Methods

We built two regression models to examine the association between chocolate-candy intake and body weight change. Both models were linear mixed models with random coefficients that contained random effects for intercept and time, with a banded main diagonal covariance matrix. This matrix structure is relatively parsimonious in that it only has two parameters. Further it accounted for the observed heterogeneous variances and small covariance between the random factors, intercept and time, in our analysis. We used likelihood ratio tests to assess results of different random effects and covariance matrix structures on model fit (13). Chocolate intake was our exposure independent variable, body weight was the dependent variable, and we included the cross product of chocolate-candy intake with time to allow for estimation of the change in body weight during the follow up period. We selected height squared as the baseline covariate in our linear mixed model. Height squared was weakly correlated with the dependent variable in our model (body weight), and yielded good model fit and a stable model.

The variables tested as potential confounders were: age (years); time (binary, year 0, 3); race/ethnicity (non-Hispanic white, other); smoking status (never, past, current <15 cigarettes/day, current >=15 cigarettes/day); physical activity, total activity at work, sports and leisure (in MET-hrs/wk); educational level (<high school; some high school -<college; some college-<postgraduate study; >=postgraduate study or degree); non-chocolate-candy daily caloric intake (kcal/day (14)); WHI study arm (OS or CT-control); self-reported prior diagnosis of a major chronic disease at year 0 (heart attack, stroke, cancer or diabetes - yes/ no); self-reported prior diagnosis of hypertension at year 0 (yes/no); family income (8 levels); employment status (3 levels); marital status (5 levels); caffeine consumption (mg/ day); modified alternative healthy eating index (15); limitations due to emotional problems (16); emotional well being (16); depression (17); sleep disturbances (18); social functioning (16); illness symptoms (18); Activities of Daily Living (18); and physical functioning (16). Our criterion for elimination/inclusion of confounders was at least a 10% change in the regression coefficient for our exposure variable, chocolate-candy consumption. The confounders in the two regression models are in table footnotes.

Paired t-tests were used to test the a-priori hypothesis, based on prior evidence (2), that obese (BMI 30.0 kg/m^2) women would decrease their chocolate-candy intake and body weight after a diagnosis of a serious chronic disease. The a-priori hypothesis that the prospective association between chocolate-candy intake and body weight would be different among those with and without a serious chronic disease was tested by inserting a cross-product interaction term of chocolate-candy intake and the prevalence of serious chronic disease in the regression model. We used similar cross-product terms to explored other subgroup analyses for age and BMI without prior hypotheses Significant interactions were elucidated by means of stratified analyses. All linear mixed models analyses were conducted with SAS (v. 9.3, SAS Institute Inc., Cary, North Carolina). Other analyses were performed using IBM SPSS Statistics (v. 20, IBM Corp., Armonk, NY).

Ethics

Our procedures were in accordance with the Helsinki Declaration of 1975 as revised in 1983. This manuscript follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations (19,20). The WHI study protocol was approved by institutional review boards at each participating institution, and all participants provided written informed consent. The ClinicalTrials.gov Identifier is NCT00000611.

RESULTS

Of the original 161,808 women, 93,676 were in the OS and 68,132 were in the clinical trials, of whom 26,515 were in the clinical trial control groups (CT-control participants). We included all OS and CT-control participants, with 120,191 at year 0 and 100,215 at year 3, representing a follow-up rate of 83.8%. We excluded participants with: 1) implausible FFQ energy intakes (21) defined as mean intakes <600 kcal/d or >5,000 kcal/d (n=4,103); 2) extreme BMI values, defined as <15 kg/m2 or >50 kg/m2 (n=1,878); or 3) height <122 cm - 4ft (n=975). We excluded women with extreme values of BMI and low height because these values could have resulted from coding errors, and these two exclusions substantially reduced the extreme values of our outcome variable, weight change during the three year study period, from 42.7 to 25.6 kg/yr. After these exclusions there were 114,281 women at year 0 and 75,489 at year 3. None of these criteria was responsible for excluding more than 3.4% of participants for implausible FFQ energy values at year 0. From these women we then excluded those with missing values on any exposure, dependent or confounder variables, leaving an analytic sample of 107,243 women at year 0 and 70,624 at year 3 who provided data for our multivariable analysis (Table 2). None of these variables had missing rates higher than 3.6% at year 0 or 3. For instance, at year 3 the missing rates for body weight, chocolate-candy intake, physical activity and smoking were 0%, 0%, 2.2% and 3.6%, respectively.

Participant Characteristics

Women who reported more frequent chocolate-candy intake reported lower physical activity, dietary quality and prevalence of serious chronic disease. They exhibited greater likelihood of Non-Hispanic White race/ethnicity. They also reported greater dietary energy intake, level of illness symptoms and level of social strain (Table 1).

Association between Chocolate-candy Consumption and Body Weight Change

The mean three-year weight gain in the entire cohort was 0.88 kg (SD=7.84). After adjusting for confounders, and with women who ate a 1 oz (~28 g) serving of chocolate candy <1 per month as referent, those who ate this amount more frequently gained significantly more weight over the three year follow-up, and the weight gain increased steadily as the frequency of consumption increased (Table 2), suggesting a dose-response relationship. There was no significant interaction between chocolate intake and diagnosis of serious chronic disease regardless of the time of diagnosis, either prior to the baseline (p=.09) or after baseline but prior to the year 3 follow-up (p=.19). When we added serious chronic disease diagnosed prior to baseline as a confounder to our full model, an extra 1 oz of chocolate-candy per day

was associated with a three-year weight gain of 0.93 (0.80, 1.06), which is essentially the same as that from the model without serious chronic disease as a confounder (Table 2).

Change in Chocolate-candy Intake After Diagnosis of a Serious Chronic Disease

Compared to obese, disease-free women, obese women diagnosed with serious chronic disease during the follow-up period between year 0 and 3 showed significant decreases in the consumption of chocolate candy, energy and fat, and body weight, across the three years. As a percentage of mean year 0 values, the mean decreases were 20.8%, 4.3%, 5.3% and 1.8%, respectively.

Secondary Analyses

We performed a separate analysis to assess the effect of adjusting for total energy intake, rather than non-chocolate energy intake, as a confounder in our main full-model. The results were essentially the same as the main results in Table 2. While more frequent chocolate-candy consumption was associated with greater weight gain in all age groups, more frequent intake was associated with greater weight gain across each of the following three BMI groups: normal weight (BMI 18.5–<25 kg/m^2), overweight (25–<30) and obese (30); with the weight gain being greatest for obese women (p-value<0.0001 for interaction by BMI, and for linear trend - Figure 1). No clear pattern was observed in the relatively small subgroup of women who were underweight (BMI <18.5 kg/m^2). We also found that the weight gain was greater in younger than older women (p-value for interaction by age <0.0001 - Figure 2). We conducted a sensitivity analysis that repeated our main full-model analysis four times - with no baseline covariate, and with three other variables as the baseline covariate: waist-to-hip ratio, waist circumference and body weight. For no baseline covariate and waist-to-hip ratio the results were essentially the same as those in Table 2. For body weight, compared to women who ate a 1 oz (~28 g) serving of chocolate candy <1 per month, those who ate this amount 1 per month to <1 per week, 1 per week to < 3 per week and 3 per week showed three-year greater prospective weight gains (kg) of 0.55 (95% CI: 0.49, 0.61), 0.64 (0.57, 0.71) and 0.94 (0.86, 1.02), respectively. For waist circumference, the estimates were intermediate between those for height squared and body weight.

We repeated our main full-model analysis in Table 2 without energy intake as a covariate. Compared to women who ate a 1 oz (~28 g) serving of chocolate candy <1 per month, those who ate this amount 1 per month to <1 per week, 1 per week to < 3 per week and 3 per week showed greater three-year prospective relative weight gains (kg) of 0.86 (95% CI: 0.77, 0.96), 1.17 (1.06, 1.28) and 1.79 (1.66, 1.92), respectively. The differences between these results and those in Table 2 could be because energy intake is in the causal pathway between chocolate candy intake and body-weight change. It seems more likely that energy intake is a regular confounder as chocolate intake constituted only 1.4% (SD=2.3%) of total energy intake in our sample.

DISCUSSION

Our main finding was that more chocolate-candy consumption was associated with greater weight gain during our three-year study period in the WHI cohort. This finding was robust

in that it did not change in sensitivity analyses which tested different confounders and baseline covariates. Each additional 1 oz daily chocolate-candy serving was associated with a mean extra three-year weight gain of 0.92 kg (95% confidence interval: 0.80, 1.05). While our estimates of weight change are subject to biases, as described below, this estimate agrees reasonably well with results from the ARIC cohort, the only previous epidemiological study on chocolate-candy consumption and prospective weight change (2). In that cohort there was a 1.09 (0.64, 1.34) kg greater increase in weight over a six-year period among ARIC participants of average height (1.68 m) who ate a 1 oz serving ≥1 per week compared to those who ate it <1 per month (2).

Our main finding, that long-term consumption of chocolate candy was associated with weight gain, most likely applies primarily to milk-chocolate candy, as milk chocolate was more popular than dark chocolate (22) when the WHI FFQ was administered. Flavanols are the compounds in cocoa that are thought to be responsible for the observed decreases in cardiovascular risk (3). Evidence from three human trials suggests that the minimum dose of flavanols needed to significantly increase vascular dilation and blood flow - the basis of the cardiovascular benefit - is 200 mg (22). If this dose is consumed daily solely through solid milk chocolate, about 10 oz/day would be needed (23), an amount likely to result in a substantial weight gain in the absence of a compensatory reduction in caloric intake from other foods. About 2 oz of solid dark chocolate are needed to provide 200 mg of flavanols (23). Consequently a dark chocolate habit seems more likely than a milk chocolate habit to be able to yield long-term cardiovascular benefits with lower risk of weight gain. In support of this possibility there is evidence suggesting that compounds in cocoa, which tend to be more concentrated in dark than milk chocolate, may help counteract weight gain (31). These compounds are postulated to decrease expression of genes involved in fatty acid synthesis, and decrease digestion and absorption of fats and carbohydrates (24). Also, dark chocolate may be able to induce stronger feelings of satiety and lead to lower energy intake than milk chocolate (25). Unfortunately, we were not able to investigate the effects of dark chocolate on body weight because the WHI data do not distinguish between different types of chocolate (e.g. white, milk, dark).

While our study, and the one other prior prospective analysis (2), found a direct association between chocolate-candy consumption and weight gain, the four prior less-rigorous cross-sectional studies (7) found an inverse association (2,4–6). The divergent findings from these two types of studies could be due to confounding effects of serious chronic disease. In obese participants in the WHI, we found a three-year decrease in chocolate-candy consumption and body weight of 20.8% and 1.8%, respectively, after a first diagnosis of a serious chronic disease. The ARIC analysis yielded a similar pattern with decreases in chocolate-candy consumption of ~33% and body weight of ~3% over a six year period (2). This pattern could explain an inverse association between chocolate-candy consumption and body weight in a cross-sectional analysis. Notably, there was a significant interaction effect for serious chronic disease in the cross-sectional ARIC analysis; but the interaction was not significant in the prospective ARIC analysis (2), nor in our prospective analysis.

We found that higher chocolate-candy intake was associated with weight gain among women in all age groups, but the weight gain was greater in younger than older women (p-

value for interaction by age <0.0001). This trend was most apparent for women in our highest intake-frequency level - a 1 oz serving more than 3 times a week: the three-year weight gain for women younger than 60 years (1.77 kg) was 77% higher than for women older than 70 years (1.00 kg). This observation could be explained by the fact that aging tends to be accompanied by decreases in body, bone, muscle and organ mass (26).

Similarly, among women who were either normal-weight, overweight or obese at baseline the weight gain associated with chocolate consumption increased as BMI increased (p-values for interaction and linear trend <.0001), and was greatest for obese women. This pattern could be due to the fact that a particular increase in caloric intake is likely to sustain a larger body weight increase in persons with higher adiposity (27). It could also be due to disruptions in gut peptide signaling leading to attenuated satiety in persons with diet-induced obesity (28, 29).

Our study has several strengths. First, the WHI cohort is large and provides adequate statistical power to detect small effects in the subgroups we examined. There were 107,243 women at year 0 and 70,624 at year 3 who provided data for our multivariable analysis. Second, the WHI dataset contains standardized body weight measurements made at two sequential time points, which allowed us to apply linear mixed model techniques to optimally use all available data to obtain precise estimates of changes in body weight over time. Third, the WHI data have been collected and validated using extensive modern empirically-proven quality-control techniques (9–11). Finally, the WHI dataset provides a wide range of possible confounding variables which allowed us to account for many factors known to affect our exposure and outcome variables. Our study also has several limitations. First, we did not have data on the type of chocolate consumed by WHI participants, as discussed above. Second, our exposure variable, chocolate-candy intake, was self reported (12). Although FFQ data are considered to be reliable for ranking participants by level of dietary intake, these data are subject to intra-individual variation, including measurement error (30). However, intra-individual variation often moves estimates closer to the null (31), so that our estimates of body weight change associated with different levels of chocolate-candy intake are likely to be underestimates. Third, our baseline covariate may not be optimal (32, 33), only two sequential measurements were available for our analysis (32), and we may not have fully accounted for confounding. Hence our estimates of weight change should be interpreted with caution.

In conclusion, we found that greater chocolate-candy consumption was associated with greater prospective three-year weight gain in a large cohort of postmenopausal women. The weight gain increased monotonically with increasing frequency of chocolate-candy consumption.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

ABBREVIATIONS

WHI	Women's Health Initiative
BMI	Body Mass Index
FFQ	food-frequency questionnaire
CT-controls	WHI clinical trial control arms
OS	WHI observational study

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Women's Health Initiative Memory Study: (Wake Forest University School of Medicine, Winston-Salem, NC) Sally Shumaker

For a list of all the investigators who have contributed to WHI science, please visit:https://www.whi.org/researchers/Documents%20%20Write%20a%20Paper/WHI%20Investigator%20Long%20List.pdf

WHAT IS ALREADY KNOWN ABOUT THIS SUBJECT

- The effect of chocolate-candy consumption on body weight has not been clarified;

- One prior prospective study in the Atherosclerosis Risk in Communities (ARIC) cohort found a positive association between chocolate-candy consumption and weight gain;

- five prior cross-sectional studies found inverse associations between chocolate-candy consumption and body weight.

WHAT THIS STUDY ADDS

- Higher chocolate-candy consumption was associated with a subsequent greater weight gain over a three-year period in the WHI cohort;

- Our findings suggest that long-term regular chocolate-candy consumption may be associated with cumulative weight gain among postmenopausal women.

- Our estimates of body weight change should be interpreted with caution as they are based on only two sequential waves of data, and are subject to residual confounding and other sources of bias.
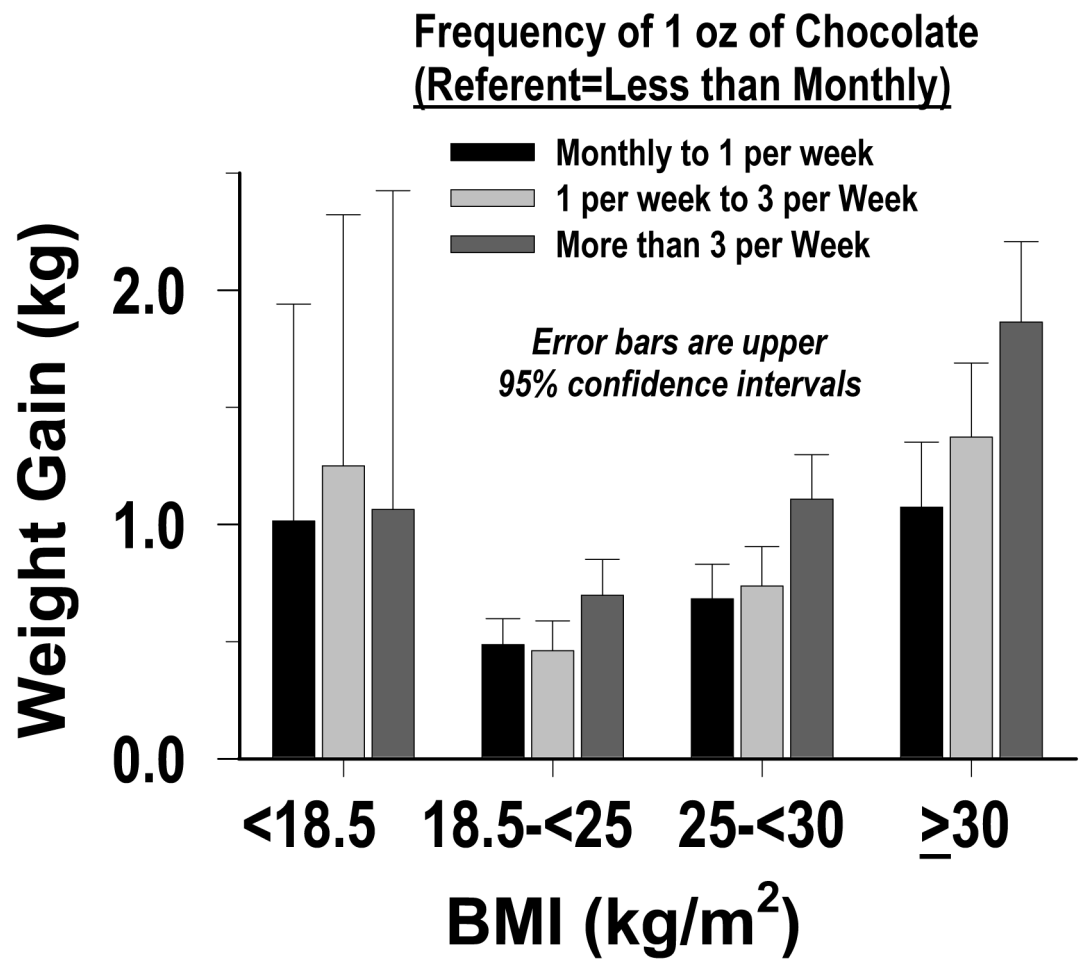
Figure 1.
Three-year Weight Gain Associated With Chocolate Candy, in Different BMI Levels (p-value for interaction by BMI <0.0001).
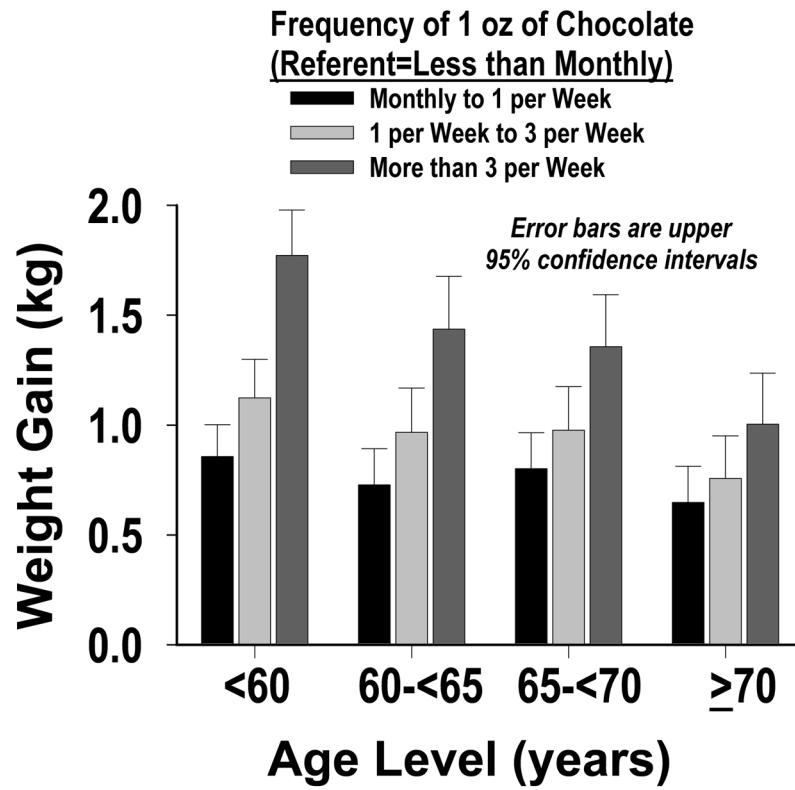
Figure 2.
Three-year Weight Gain Associated With Chocolate Candy, in Different Age Levels (p-value for interaction by age <0.0001).

Table 1

Characteristics [1] of post-menopausal women in relation to Chocolate Candy Intake in the Women's Health Initiative, Mean (SD) or %.

Characteristics-	Frequency of Consumption of a 1oz Serving of Chocolate Candy			
	<1 per month (N=27,960)	1 per month to <1 week (N=31,877)	>1 week to <3 per week (N=17,843)	3 per week (N=13,191)
Chocolate Candy (1 oz servings/day)	0.00 (0.01)	0.06 (0.03)	0.21 (0.07)	0.79 (.53)
Body Weight (kg) [2]	70.1 (14.9)	72.3 (14.9)	71.9 (14.8)	74.9 (15.9)
Age (years)	63.9 (7.2)	63.2 (7.1)	63.6 (7.3)	63.3 (7.3)
Race/ethnicity (%)				
non-Hispanic white	81.9	86.8	90.2	90.2
non-Hispanic black	9.6	7.2	4.7	5.3
Other	8.5	5.9	5.1	4.5
Education (%) [3]				
<high school	20.9	20.1	19.6	20.7
high school -<college	36.9	36.6	37.2	37.9
college-<postgrad. study	23.1	24.1	23.9	23.5
>=postgrad. study/degree	19.1	19.2	19.3	17.8
Physical Activity (MET-hrs/wk) [3]	14.8 (15.1)	13.2 (13.7)	12.34 (13.1)	11.1 (12.9)
Total dietary calories (kcal/day)	1423.3 (531.8)	1556.8 (560.7)	1689.2 (598.9)	2013.1 (720.3)
Non-chocolate calories(kcal/day)	1422.9 (531.8)	1548.9 (560.3)	1662.0 (598.3)	1909.8 (707.8)
Smoking (%)				
Never	50.3	50.0	52.2	50.1
Former	43.8	43.7	41.0	42.1
current <15/day	3.1	3.4	3.5	3.4
current >=15/day	2.7	2.9	3.3	4.4
Healthy Eating Index [4]	51.5 (10.0)	49.5 (9.7)	48.3 (9.6)	46.3 (9.9)
Family Income ‡	4.29 (1.88)	4.37 (1.80)	4.38 (1.80)	4.33 (1.80)
Serious Chronic Disease (%) [5]	19.6	16.0	15.4	15.2
Illness Symptoms [6]	0.41 (0.27)	0.43 (0.26)	0.43 (0.26)	0.46 (0.27)
Physical Functioning [6]	81.9 (20.1)	82.3 (19.2)	81.8 (19.0)	80.2 (19.9)
Social Strain [6]	6.4 (2.5)	6.5 (2.5)	6.5 (2.5)	6.7 (2.5)
Postmenopausal Hormones (%)				
Never	32.9	29.8	29.6	30.5
>3mo ago	19.6	19.3	19.6	20.4
<=3mo ago	47.5	51.0	50.8	49.2

There were significant differences across levels of chocolate candy intake (p<.05), based on the analysis of variance, Kruskal-Wallis test, or Chi-square test.

[1] Data are given as mean (SD) for continuous variables and as percentages for categorical variables. Data are for participants with no missing values for any of the characteristics in this table.

[2] Body weight, measured weight in lb.

[3] Educational level, Physical activity and Family Income were quantified by WHI researchers. Physical activity was total energy expended in recreational physical activity. Family Income ranged from 1–8).

[4] the Modified Alternative Healthy Eating Index (15).

[5] Serious chronic illness was self-reported preexisting diagnosis of heart attack, stroke, diabetes or cancer.

[6] Illness Symptoms Construct, range, 0–3 (18); Physical Functioning Construct, range 0–100 (16). Social Strain Construct, range 4–20 (18).

Table 2

Chocolate Candy Intake[1] and Three-year Change in Body Weight among Post-menopausal Women in the Women's Health Initiative (WHI) Cohort.

Chocolate Candy Intake (1 oz Serving)	Adjusted for Age, Race/ethnicity & WHI Study Arm			Adjusted for all Confounders[4]		
	N[2] at Year 0	N at Year 3	Body Weight Change (kg)[3]	N at Year 0	N at Year 3	Body Weight Change (kg)
<1/month	35205	22602	0 (REFERENT)	33636	21594	0 (REFERENT)
1/month – <1/week	39208	24920	0.85 (0.76, 0.95)	37279	23761	0.76 (0.66, 0.85)
1/week – <3/ week	21983	15743	1.16 (1.05, 1.27)	20938	15029	0.95 (0.84, 1.06)
3/ week	16296	10695	1.78 (1.65, 1.90)	15390	10240	1.40 (1.27, 1.53)
An Additional 1 oz per Day	112692	73960	1.29 (1.16, 1.41)	107243	70624	0.92 (0.80, 1.05)
P for Linear Trend[5]			<.0001			<.0001
P for Quadratic Trend[5]			<.0001			<.0001

Data are presented as mean (95% confidence interval) estimated by means of a linear mixed effects model, in which the exposure and outcome variable and confounders were updated at year 3 (see text for details).

[1] Frequency of chocolate-candy intake was assessed by means of a semi-quantitative food frequency question.

[2] N is the number of participants who provided data values in each of the categories of chocolate-candy intake at year 0 & 3.

[3] Body weight change is the change in kg during the three year period between year 0 and 3:1) among participants in a particular chocolate-candy intake category, compared to participants who reported eating chocolate candy <1/ month (referent category); and 2) among all participants. The change is associated with the consumption of an additional 1 oz of chocolate candy per day.

[4] Adjusted for age (year); time (year 0 and 3); chocolate-candy intake (1 oz servings/day)*time; baseline height squared; smoking status (never, past, current <15/day, current >=15/day); physical activity (total activity at work, sports and leisure, in MET-hrs/wk); educational level (<high school; Some high school <college; some college-<postgraduate study; >=postgraduate study or degree); non-chocolate daily caloric intake (kcal/day); modified alternative health eating index. All confounders were continuous or binary variables.

[5] Tests for linear trend were performed by putting the linear version of chocolate-candy intake in the model. Tests for quadratic trend were performed by putting the linear and quadratic version of chocolate-candy intake in the model.