Chocolate and Lower Body Weight   
  
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Overview  
Recent research has brought to light the beneficial health effects of chocolate.  Studies have linked chocolate with lower blood pressure, lower bad cholesterol, improved insulin sensitivity, and reductions in the risks of diabetes, heart disease, and stroke.  The authors of this study hypothesized that chocolate’s healthful metabolic mechanisms might also reduce fat deposition in spite of its high caloric content.

This study used the baseline data from a clinical study that examined noncardiac effects of cholesterol-lowering drugs in healthy adults.  The baseline data included body mass index (BMI), chocolate consumption frequency, age, sex, physical activity frequency, depression, and some dietary variables.  Chocolate consumption frequency was assessed with the question: “How many times a week do you consume chocolate?”  Dietary intakes of total calories, fruits and vegetables, and saturated fat were assessed with a validated food frequency questionnaire.  A food frequency questionnaire is a limited checklist of foods and beverages with a frequency response section for subjects to report how often each item was consumed over a specified period of time.  Depression was measured with a validated scale related to mood.  BMI is a measure of body fatness that is associated with many adverse health conditions.  
  
Questions to Answer  
What can we conclude from the researchers’ findings that there is an association between consuming chocolate frequently and lower BMI?  How do we interpret regression models?

Design Issues   
The authors used baseline data from an unrelated clinical study examining noncardiac effects of cholesterol-lowering drugs.  That clinical study included men ranging in age from 20 to 85 years, but only postmenopausal women.  The results of the chocolate study cannot, therefore, be generalized to younger adult women.  Except for BMI, the data for all of the study variables were “self-reported” by the subjects via questionnaires.  The assessment of critical variables, such as chocolate consumption frequency and vigorous physical activity frequency, could differ when using different measurement tools.  The study was cross-sectional in nature, precluding conclusions about causation.

Descriptions of Variables

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| **VARIABLE** | **DESCRIPTION** |
| BMI | Body mass index, calculated as: (weight in kilograms) / (height in meters)2 |
| Chocolate consumption frequency | Number of times per week a subject consumed chocolate |
| Calories | Overall calorie intake of a subject determined via food frequency questionnaire |
| Age | Range of 20 to 85 years, postmenopausal if female |
| Sex | 68% male, 32% female |
| Activity | Number of times per 7-day period a subject engaged in vigorous physical activity for at least 20 minutes |

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| References |
| Golomb, B. A., Koperski, S., White, H. L. (2012). Association between more frequent chocolate consumption and lower body mass index. *Archives of Internal Medicine*, 172, 519-521.  Rose, N., Koperski, S., Golomb, B. A. (2010). Mood food: chocolate and depressive symptoms in a cross-sectional analysis. *Archives of Internal Medicine*, 170, 699-703. |

Links

[Golomb *et al*. article](javaScript:newWindow2('http://archinte.jamanetwork.com/article.aspx?articleid=1108800','850'))  
[Rose et al. article](javaScript:newWindow2('http://archinte.jamanetwork.com/article.aspx?articleid=415834','850'))  
[Chocolate, a health food?](javaScript:newWindow2('http://www.yaledailynews.com/news/2012/apr/03/a-chocolate-a-day-keeps-the-doctor-away/','850'))  
[What is body mass index (BMI)?](javaScript:newWindow2('http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html/','850'))  
[What is a food frequency questionnaire?](javaScript:newWindow2('http://dapa-toolkit.mrc.ac.uk/dietary-assessment/methods/food-frequency-questionnaire/index.html','850'))

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| Exercises |
| Please read the Golomb *et al.* article before performing the exercises.  Please refer to the single **Table** in the article presenting the regression results.   1. Some of the predictor variables in the study are confounders.    1. What is the definition of a confounder?    2. Give two examples of confounders in the study and explain why they are confounders. 2. Many studies have shown an inverse association between educational level and BMI, namely, higher educational attainment is associated with lower BMI.  Approximately 58.8% of the subjects in this study were college graduates (see additional reference by Rose et al.).    1. Should education have been controlled for in the regression analysis?  Why or why not?    2. Can you think of other possible variables to control for? 3. What does it mean to predict the effect of chocolate consumption frequency on BMI adjusting for calories?  Why is it debatable whether or not to adjust for calories? 4. Can you tell how many subjects were included in each of the regression models presented in the **Table**?  Is it important that all of the regression models be based on the same sample size (n) consisting of exactly the same individuals?  Why or why not? 5. The unadjusted model in the **Table** represents a simple linear regression model.  The mean (SD) BMI of the subjects was 28 (4.5) and the mean (SD) of their chocolate consumption frequency was 2.0 (2.5).    1. What is the slope (b) of the regression line?    2. Estimate the Y-intercept (A) using the formula: A = MY - bMX.    3. State the equation for the regression line of the unadjusted model.    4. What is the predicted BMI of a subject who eats chocolate 3 times per week?    5. Estimate the correlation coefficient (r) between chocolate consumption frequency and BMI using the formula: r = b(SDX/SDY).    6. Estimate the proportion of variance explained in the unadjusted model.  What do you conclude? 6. Consider the multiple regression model in the **Table** that adjusts only for age, sex, and activity.    1. Interpret the regression coefficient for chocolate consumption frequency.    2. Based on this model, if two subjects were the same sex and age and engaged in the same frequency of vigorous physical activity, but differed by 3 in the number of times they consumed chocolate per week, by how much would you predict their BMIs would differ?    3. For comparison, based on the unadjusted model, by how much would you predict their BMIs would differ?    4. Interpret your answers to b. and c. 7. A major limitation of cross-sectional studies is that a cause-and-effect relationship cannot be inferred from the results (see additional reference by Rose et al.).    1. What possible mechanisms do the authors propose that might support a causal relationship between eating chocolate frequently and lower BMI?    2. Propose two other possible explanations that are compatible with the findings of an association, one supporting each direction of a possible causal relationship. 8. Future studies are required toward establishing chocolate as a therapy for excess weight.  How might you design an experiment testing whether or not chocolate therapy could lead to weight loss?  What would be the most appropriate population for your research study? |