

Impact of Change in Sweetened Caloric Beverage Consumption on Energy Intake Among Children and Adolescents

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Estimating Within-Person Effect of Beverage Intake Using Fixed-Effects Regression Model

For the 2 consumption days ($t=1, 2$) reported by each person i , we estimate

$$1. Y_{it} = a_i + u_t + \beta \times X_{it} + \gamma \times Z_i + \epsilon_{it}$$

Y_{it} represents the outcome of interest of surveyed day t for subject i (eg, total energy intake or total calories consumed throughout the 24-hour period). Z_i represents a vector of demographic variables of the subject that do not vary between the 2 surveyed days (such as race, sex, and age). X_{it} are variables that change between individuals and between the 2 days for each individual, ie, a binary variable indicating whether day t is a fast-food or a non-fast-food day and the mode of interview being in person vs over the telephone. a_i and u_t are intercepts for person i and time t , respectively, representing effects that are not otherwise accounted for by $\gamma \times Z_i$ and $\beta \times X_{it}$. β and γ represent the within-person effect of X and between-person effect of Z on Y_{it} . We assume that ϵ_{it} is uncorrelated between individuals. However, we do not require that ϵ_{it} be uncorrelated with Z_i or a_i .

For each subject i , based on the recall data from day 1 and day 2, we can therefore obtain 2 equations:

$$2. Y_{i1} = a_i + u_1 + \beta \times X_{i1} + \gamma \times Z_i + \epsilon_{i1}$$

$$3. Y_{i2} = a_i + u_2 + \beta \times X_{i2} + \gamma \times Z_i + \epsilon_{i2}$$

Subtracting equation 2 from equation 3:

$$4. Y_{i2} - Y_{i1} = (u_2 - u_1) + \beta \times (X_{i2} - X_{i1}) + (\epsilon_{i2} - \epsilon_{i1})$$

In other words, the time-constant parameters, Z_i , are subtracted out, and the within-person effect on the outcome variable is therefore estimated through β . This model assumes that the sugar-sweetened beverage consumption pattern on day 2 does not depend on the value of Y on day 1. Given that the second-day survey was conducted 3 to 7 days later, rather than immediately follow-

ing the first day, we consider this assumption reasonably valid.

In our present study, we fit 2 fixed-effects models to examine the mean changes in total energy intake (the dependent variable) associated with changes in beverage intake. The first model (see Table 2 in our article "Impact of Change in Sweetened Caloric Beverages on Energy Intake Among Children and Adolescents") parameterized the independent variables (X_i) by changes in number of servings (1 serving=8 oz) of each beverage. This model assumes a linear relationship between level of consumption and the change in total energy intake, the dependent variable (Y_i). The model included changes in servings for all beverage categories and therefore did not include a measure of total grams of beverages consumed as a covariate to avoid redundancy. However, this model does control for other time-varying variables, such as total nonbeverage intake (in grams), and indicator variables for weekday vs a weekend, fast-food intake (yes/no), and in-person vs telephone interview.

The second model—the "replacement model"—estimated the effect on net caloric consumption from replacing different caloric beverages with other alternatives. Independent variables for different beverages are hereby characterized by the percentage of all beverages (measured in grams). The reference variable is not included in the covariate sets and therefore represents the beverage being replaced. The resulting model can estimate the average difference in total energy intake associated with replacing 1 unit of sugar-sweetened beverage (1% of beverages) with water, for example. The model controls for total beverage intake and total nonbeverage intake (both in grams). This approach is similar to the replacement models used by Stookey et al,¹ except that we controlled for total grams of nonbeverages instead of controlling for food macronutrient composition.

REFERENCE

1. Stookey JD, Constant F, Gardner CD, Popkin BM. Replacing sweetened caloric beverages with drinking water is associated with lower energy intake. *Obesity (Silver Spring)*. 2007;15(12):3013-3022.