Separating what we eat from where: Measuring the effect of food away from home on diet quality

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ABSTRACT

Many argue that food away from home (FAFH) is a contributing factor to the obesity epidemic, showing that body mass index and consumption of FAFH are positively correlated. However, correlation analyses using a simple regression approach, such as the Ordinary Least Squares (OLS), do not prove that FAFH causes weight gain. We use a first-difference estimator to establish a causal relationship between FAFH and dietary intakes. Using dietary recall data from the 2003–2004 National Health and Nutrition Examination Survey and the 1994–1996 Continuing Survey of Food Intakes by Individuals, we find that FAFH does indeed increase caloric intake and reduce diet quality, but that the effect is smaller than if estimated using OLS. Thus, models based on associations are likely biased upward, as much as 25% by our estimates.

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Introduction

Despite repeated public health messages about the importance of a healthy diet and lifestyle, most Americans continue to choose low quality diets and obesity rates continue to rise. One frequently cited reason for persistently poor diets is today’s food environment, which offers many opportunities to make unhealthy food choices. Busy schedules may also affect the quality of the food we eat by changing the regularity with which we eat, time available for meal preparation, and consumption of foods prepared away from home. Consumers today spend an increasing share of their food expenditures on food away from home (FAFH). In 2007, families spent nearly 42% of their food dollars on foods outside the home, up from 25% in 1970 (Clausen and Leibtag, 2008).

This increased consumption of FAFH has often been cited as a contributor to obesity and low diet quality among Americans. The bulk of existing research investigating this link, however, has focused on documenting correlations by showing that poor diet quality or high body mass indices (BMI) are associated with greater consumption of FAFH (Binkley et al., 2000; Clemens et al., 1999; Guthrie et al., 2002; Paeratakul et al., 2003; Bowman et al., 2004; Bowman and Vinyard, 2004; Binkley, 2008). Such correlations, however, do not account for the fact that the choice of where to eat is jointly determined with the choice of what to eat. Thus, while individual preferences, food prices, income and time constraints influence FAFH consumption, diet quality and weight, FAFH consumption may or may not have direct influence on either diet quality or weight.

It may be that individuals who consume a high share of FAFH also prefer lower nutritional quality foods when eating at home. Or, if the time demands of family and work raise demand for convenient foods, both at and away from home, and also reduce time available for physical activity, then BMI levels among individuals who eat more convenient foods would likely be higher than those who do not. Thus not accounting for the fact that people simultaneously decide what to eat and where to get it will bias the estimated impact of FAFH on diet quality. Correlation analysis also obscures the possibility that individuals compensate less healthy FAFH choices with healthier choices at other meals throughout the day.

Unbiased measures of the impact of FAFH on diet quality and calories consumed are needed to accurately assess the efficacy of proposed policies for improving diet quality. For example, if poor dietary choices are just more prevalent among certain individuals, regardless of where they get their food, then mandatory FAFH labeling requirements may have little impact. If, on the other hand, individuals unknowingly eat less healthfully when eating away from home and do not know how to compensate for this indulgence over the rest of the day, then FAFH labeling and consumer education on ways to make more healthful choices when choosing FAFH could have significant payoff, especially if problems of self-control are exacerbated when eating FAFH (Cutler et al., 2003; Mancino and Kinsey, 2008). As such, making information on the
nutrient content of FAFH more prominent may make it easier for people to achieve their own dietary goals.

This study provides more precise estimates on how food away from home affects both caloric intake and diet quality. We overcome much of the endogeneity issue by employing a fixed effect estimator utilizing 2-day dietary intake data. We assume that overall preferences for diet quality are fixed over time within individuals, but day-to-day variation in activities and other constraints affects consumption of FAFH. Because the dietary recalls are collected within a short period of time, typically 7–10 days apart, this is a reasonable assumption. This allows us to identify FAFH's daily effect on diet quality and energy consumption.

Data and estimation approach

This analysis is based on two nonconsecutive days of dietary recall data from the 2003–2004 National Health and Nutrition Examination Survey (NHANES)1 and the 1994–1996 Continuing Survey of Food Intakes by Individuals (CSFII). We focus our analysis on adults, so limit our sample to respondents aged 20 and older. We use the 2-day dietary recall sample weights for both NHANES and CSFII and use STATA 10.1 to account for the complex survey design of each survey. Specifically, we use data on the primary sampling unit, survey round (NHANES or CSFII) and strata identifiers to adjust standard errors. As dependent variables, we focus on two indicators of diet quality. The first is the change in an individual’s total daily caloric intake. The other dependent variable is the change in an individual’s total daily caloric intake from fast food, table service restaurants, cafeterias or taverns. We classify each meal as either breakfast, lunch, dinner or a snack. Because eating patterns may change on weekends, we also controlled for weekend eating on which meal or meals an individual obtains from FAFH. We use the respondent’s stated definition of an eating occasion to classify each meal as either breakfast, lunch, dinner or snack. Because eating patterns may change on weekends, we also controlled for whether or not an intake day occurred on a Saturday or Sunday. Two-day sample means and within individual differences for the two intake days for our explanatory and dependent variables are reported in Table 1.

If FAFH consumption on a given day, \( t \), is exogenous to an individual’s unobserved preferences that also influence diet quality, we can estimate the effect of FAFH on diet quality for day \( t \) using the Ordinary Least Squares estimator (OLS).

\[
DQ_{it} = \alpha + \beta X_i + \gamma FAFH_{it} + \nu_{it}
\]

The coefficient on FAFH, \( \gamma \), would provide an estimate of the effect of an increase in FAFH (let’s say an additional meal away from home) on diet quality. If however, FAFH is correlated with the error term, estimates of how FAFH impacts diet quality will be biased (Green, 1990). With multiple days of dietary intake data, we can decompose the error term \( \nu_{it} \) into an individual error component \( \mu_i \) that is time-invariant within individuals, and an additional stochastic component, \( \epsilon_{it} \), that has the usual independent and identically distributed (iid) properties.

\[
DQ_i = \alpha + \beta X_i + \gamma FAFH_i + \mu_i + \epsilon_{it}
\]

For example, \( \mu_i \) could be someone’s unobservable preference for locally grown, vegetarian foods that affects both the incidence of eating food away from home and the foods chosen when eating at home. Not controlling for this unobservable, but relevant factor would then exaggerate FAFH’s estimated influence on diet quality.

Thus, we must separate the choice over the amount of FAFH from the individual’s overall preference for nutrition and diet quality. If we assume that these unobservable preferences \( \mu_i \) are fixed over time, we can employ a fixed effect, or in our case since only 2-days of dietary recall are used, a first-difference estimator. This first-difference model removes all time-invariant characteristics and allows us to estimate the effect of an increase in the number of meals consumed from FAFH on the measure of diet quality that is not biased by these unobserved factors.2 However, this method will not account for unobserved factors that vary over time, such as fluctuations in individuals’ daily schedules, social obligations or appetite. To attempt to control for these unobserved time-varying factors, we incorporate changes in meal patterns, such as snacking and eating breakfast, and whether consumption was observed on a weekday or weekend:

\[
\Delta DQ_i = \gamma (\Delta FAFH_i) + \sum_{j=1}^{4} \phi_j (\Delta MEAL_{ij}) + \beta (\Delta weekend_i) + \Delta \epsilon_i
\]

where \( \Delta DQ_i \) measures the change in diet quality for individual \( i \). The subscript \( j \) represents a particular meal (breakfast, lunch, dinner or snack) and \( \epsilon \) is an iid stochastic error term. Thus, the coefficient on \( \Delta FAFH \), \( \gamma \), will provide a less biased estimate of the average effect of obtaining one additional meal from FAFH on diet quality than estimates obtained from OLS estimation.

However, the effect of FAFH on diet quality may differ depending on which meal or meals an individual obtains from FAFH. We replace the change in the number of meals from FAFH in Eq. (3) with separate indicators for whether each type of meal was consumed from FAFH.

\[
\Delta DQ_i = \sum_{j=1}^{4} \phi_j (\Delta MEAL_{ij}) + \sum_{j=1}^{4} \theta_j (\Delta MEAL_{ij}) (FAFH_{ij})
\]

+ \( \beta (\Delta weekend_i) + \Delta \epsilon_i \)  

In Eq. (4), the coefficient on each interaction term, \( \theta_j \), estimates the effect of consuming the particular meal from FAFH on diet quality. Differentiating the effects of FAFH meal occasions on diet quality may illuminate ways to design more effective interventions to improve decision making.

We first estimate Eqs. (3) and (4) with pooled 1994–1996 and 2003–2004 data. Then we estimate both equations separately for the 1994–1996 and 2003–2004 samples to detect whether the effect of eating out on dietary quality has changed over time. Our

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1 At present, we are not able to calculate Healthy Eating Index scores for the 2005–2006 NHANES data because the corresponding MyPyramid Equivalent database has not been released.

2 Results of Hausman Tests checking for systematic differences between random and fixed effects estimators rejected the null hypothesis that the time-invariant error term is uncorrelated with other regressors. With either calories or diet quality as dependent variables, we were able to reject this hypothesis at \( p < .0001 \). For calories, the Chi-squared value was 35.34. For overall diet quality, this test statistic was 227.48.
approach is motivated by recent changes in the commercial food service industry. Spurred by the urgent need to reduce obesity and the common belief that FAFH may be a contributing factor, many municipalities have instituted legislation or regulations modifying the types of information provided to consumers in fast food and other restaurants. In addition, many restaurants have begun to provide nutritional information for menu items, as well as to modify their menu choices. These supply-side changes may have changed how FAFH affects overall diet quality.

The effect of FAFH may also vary across demographic groups. We examine the difference between men and women, following several studies that have found that men and women differ significantly in dietary patterns (Binkley et al., 2000; Kuchler and Lin, 2002). We also compare obese individuals (defined as those whose BMI is at least 30) to individuals who are not overweight (defined as those whose BMI is less than 25). If dietary intake among obese individuals is more responsive to FAFH, then improving its nutrient content could have an especially big payoff. Similarly, a more pronounced effect among individuals who are dieting may indicate that improving the transparency of nutrition information would make it easier to act on one’s dietary intentions. Thus, we also compare individuals on a low calorie or low fat diet to those who are not.

Results – the effect of FAFH on diet quality

Our results indicate that, even after controlling for endogeneity issues, FAFH has a significant impact on various measures of diet...
quality. Using the model described in Eq. (3), we find that each meal away from home is estimated to add 130 calories to total daily calories, and lower HEI scores by two points (Table 2).

It is important to note that these estimates are significantly lower than those obtained by running a simple OLS regression of daily calories or HEI on the number of meals consumed away from home. The OLS estimates are roughly 25–28% larger than the first-difference estimates, which is consistent with the idea that the characteristics that adversely influence energy intake and diet quality are positively correlated with eating FAFH. Thus, it is important to control for unobserved differences in preferences for both diet quality and FAFH.

Using the first-difference estimates, we find that eating one meal away from home each week, other things being equal, would translate to roughly two extra pounds each year. In 2005–2006, NHANES data indicate that individuals age 20 and older consumed on average, four meals away from home, per week. If these four away from home meals are replaced by at home meals, an individual can shed 8 lb in a year, which translates into a reduction in BMI of 1.16 for an average man and 1.36 for an average woman.3

We next examined how the impact of FAFH varies depending on other subgroup analyses (Tables 4–6). We find that the effect of the total number of FAFH meals comes from estimating Eq.(3). The parameter estimate for the dinner away from home is estimated to add 137 calories, while a snack would contribute 122 calories. This disproportionate change in HEI relative to calories is likely due to the fact that people are more likely to eat more fats and added sugars when eating breakfast out as compared to when eating it at home.

We ran separate estimates on 1994–1996 CSFII and 2003–2004 NHANES data to test whether the impact of FAFH had changed significantly over this period (Table 3). The parameter estimate for the total number of FAFH meals comes from estimating Eq. (3). The four parameter estimates for the interaction between FAFH and specific meals come from estimating Eq. (4). For simplicity, we combine both results into a single table and only report the coefficients for these five FAFH variables. We use this same format for all other subgroup analyses (Tables 4–6). We find that the effect of the total number of meals eaten away from home on daily calories and diet quality has not changed significantly over this time period. The only significant difference is that an away from home dinner has a greater impact on caloric intake in 2003–2004 as compared to the earlier period. We were also interested in how the impact of FAFH differs by gender. While the difference in point estimates of the impact of the total number of meals away from home is significant at the 10% probability level, the effect of individual meals are not significantly different. We find no distinct difference in how FAFH influences HEI scores between men and women (Table 4).

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Table 3
Effect of FAFH meals on energy and diet quality, by survey year, first-difference estimates.

<table>
<thead>
<tr>
<th>CSFII compared to NHANES</th>
<th>HEI</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>CSFII</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of meals FAFH*</td>
<td>117.351</td>
<td>(13.38)</td>
<td>144.958</td>
<td>(22.38)</td>
<td>-1.848***</td>
<td>(0.18)</td>
<td>-2.098 (0.43)</td>
</tr>
<tr>
<td>Breakfast away from homeb</td>
<td>123.311</td>
<td>(41.65)</td>
<td>28.977</td>
<td>(59.96)</td>
<td>-4.239***</td>
<td>(0.54)</td>
<td>-4.643** (1.23)</td>
</tr>
<tr>
<td>Lunch away from homeb</td>
<td>151.896</td>
<td>(20.87)</td>
<td>161.800</td>
<td>(24.18)</td>
<td>-1.794**</td>
<td>(0.40)</td>
<td>-2.234** (0.69)</td>
</tr>
<tr>
<td>Dinner away from homeb</td>
<td>66.976***</td>
<td>(29.80)</td>
<td>200.181***</td>
<td>(42.06)</td>
<td>-1.920***</td>
<td>(0.44)</td>
<td>-1.671** (0.65)</td>
</tr>
<tr>
<td>Snack away from homeb</td>
<td>122.865***</td>
<td>(28.16)</td>
<td>94.993</td>
<td>(88.14)</td>
<td>-0.984**</td>
<td>(0.36)</td>
<td>-1.274 (0.86)</td>
</tr>
</tbody>
</table>

Complex survey design accounted for in regression; survey weights applied.

* Parameter estimate derived from estimating Eq. (3).
* Parameter estimate derived from estimating Eq. (4).
* Coefficient is significant at \( p < 0.1 \).
** Coefficient is significant at \( p < 0.05 \).
*** Coefficient is significant at \( p < 0.01 \).
** Difference between the two survey periods is significant at \( p < 0.05 \).

Table 4
Effect of FAFH meals on energy and diet quality, by gender, first-difference estimates.

<table>
<thead>
<tr>
<th>Men compared to women</th>
<th></th>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>CSFII</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of meals FAFH*</td>
<td>157.862**</td>
<td>(20.49)</td>
<td>99.442***</td>
<td>(18.70)</td>
<td>-1.864***</td>
<td>(0.29)</td>
<td>-2.118*** (0.32)</td>
</tr>
<tr>
<td>Breakfast away from homeb</td>
<td>161.811**</td>
<td>(44.42)</td>
<td>31.183***</td>
<td>(53.91)</td>
<td>-4.683***</td>
<td>(1.06)</td>
<td>-4.103*** (0.70)</td>
</tr>
<tr>
<td>Lunch away from homeb</td>
<td>182.014***</td>
<td>(26.81)</td>
<td>134.827***</td>
<td>(26.71)</td>
<td>-1.670***</td>
<td>(0.46)</td>
<td>-2.265*** (0.65)</td>
</tr>
<tr>
<td>Dinner away from homeb</td>
<td>562.572***</td>
<td>(41.58)</td>
<td>113.133***</td>
<td>(25.68)</td>
<td>-1.607***</td>
<td>(0.46)</td>
<td>-2.077*** (0.63)</td>
</tr>
<tr>
<td>Snack away from homeb</td>
<td>135.030***</td>
<td>(55.48)</td>
<td>57.596 (49.92)</td>
<td>-0.976**</td>
<td>(0.39)</td>
<td>-1.314 (0.80)</td>
<td></td>
</tr>
</tbody>
</table>

Complex survey design accounted for in regression; survey weights applied.

* Parameter estimate derived from estimating Eq. (3).
* Parameter estimate derived from estimating Eq. (4).
* Coefficient is significant at \( p < 0.05 \).
** Coefficient is significant at \( p < 0.1 \).
*** Coefficient is significant at \( p < 0.01 \).
** Difference between men and women is significant at \( p < 0.1 \).
As FAFH has been cited as a primary cause of obesity, we ran both equations separately on healthy-weight and obese individuals to determine if FAFH impact differs by body weight status. While NHANES includes both measured and self-reported BMI, the CSFII only includes the latter. Thus we separated our sample based on self-reported BMI to determine if FAFH impact differs by body weight status. While BMI is not a perfect measure of adiposity, we only includes the latter. Thus we separated our sample based on NHANES includes both measured and self-reported BMI, the CSFII to determine if FAFH impact differs by body weight status. While BMI is not a perfect measure of adiposity, we only includes the latter. Thus we separated our sample based on NHANES includes both measured and self-reported BMI, the CSFII to determine if FAFH impact differs by body weight status.

For every meal except breakfast, the effect of FAFH on daily caloric intake is significantly higher for obese individuals. While eating an additional meal away from home is estimated to add nearly 240 calories to an obese person's daily intake, it is estimated to add less than 90 calories to a non-obese person's intake. This supports other studies that find obese individuals do not compensate their increased caloric intake at one meal with reduced intake throughout the rest of the day (see for example, Ebbeling et al., 2004). It is interesting to note that the impact of FAFH on diet quality also varies significantly, but in the opposite direction. Our regression results indicate that on average, obese individuals have higher HEI.

Finally, we compared the effects for individuals who reported they were on a low fat or low calorie diet against those who were not dieting. Again, we find that eating breakfast, lunch or snacks away from home increases total daily caloric intake even for individuals trying to watch their total daily calories (Table 6). However, the difference in the impact is significant only for breakfast away from home. This may indicate that dieters have more trouble compensating for the relatively less healthy food available away from home, or are more likely to splurge in the more tempting environment. Requiring nutritional information in restaurants or increasing the availability of healthier choices may be particularly beneficial for this group.

### Discussion and policy implications

Many argue that FAFH is a contributing factor to the obesity epidemic, showing that BMI and consumption of FAFH are positively correlated. We argue that many previous estimates of the effect of FAFH are likely biased due to the failure to treat FAFH as endogenous. FAFH is affected by personal preferences, food prices, income and time constraints, some of which may affect dietary quality as well. We address the endogeneity issue by estimating the effect of FAFH on energy intake and diet quality using a first-difference estimator, which isolates the effect of FAFH from an endogenous. FAFH is affected by personal preferences, food prices, income and time constraints, some of which may affect dietary quality as well. We address the endogeneity issue by estimating the effect of FAFH on energy intake and diet quality using a first-difference estimator, which isolates the effect of FAFH from an endogenous. 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caloric intake and reduce diet quality, but that the effect is smaller than if estimated using OLS, which does not account for unobserved individual preferences and other fixed characteristics influencing food choices, including consumption of FAFH. Thus, results from naïve models are biased upward, as much as 25% by our estimates.

Our estimates of the effect of specific meals reveals that lunch and dinner consumed away from home have the largest effect on total daily calories, but that breakfast has the largest negative effect on total HEI. Eating lunch and dinner away from home also reduces diet quality. Previous research has documented that FAFH is on the rise and has become more popular, and that it is associated with negative health consequences. It is estimated that 70% of American adults report eating at least one meal away from home per day. One reason for the increase in FAFH consumption is the availability of nutritional information, including calorie counts, which has been shown to influence food choices when eating away from home. We also find that the effect of FAFH on caloric intake persists and may even become more pronounced among individuals who, theoretically, should have strong incentives to make healthy FAFH choices, such as dieters and those who are obese.

These findings are consistent with the argument that a lack of dietary information about FAFH makes it difficult to make healthy choices when eating away from home. Our findings also suggest that increasing transparency about calorie and nutrient content in FAFH could help to reduce FAFH’s negative impact on diet quality. We find that FAFH increases total energy intake more for obese individuals than for those in the healthy weight range, as measured by BMI, as well as for those reporting to be on a low calorie or low fat diet. This suggests that requirements for nutrition labeling in the FAFH sector may benefit these groups the most. In addition to labeling requirements, the Federal government can also make dietary recommendations regarding consumption of FAFH. The Dietary Guidelines (DG) Advisory Committee has been convened to work on the 2010 DG (USDA/USDIHHS, 2009). This committee will review the strength of scientific evidence when considering specific recommendations. While previous findings of correlations between FAFH and dietary outcomes provide a weak scientific base to form dietary advice on FAFH, our estimates provide evidence that FAFH does cause an increase in caloric intake and hence contribute to weight gain.

With increasing attention on FAFH’s possible role in promoting poor diet quality and weight gain in the country, many restaurants have voluntarily added healthier items to their menus or have provided nutritional information (CSPI, 2003; Warner, 2005). This increased availability of healthier options as well as additional information may have modified the effect of FAFH by allowing individuals to make choices more consistent with their choices at home. We tested this by estimating the effect separately for each period covered in our data. Despite the increased attention of the negative attributes of FAFH and efforts of private companies, we find little change in the effect of FAFH on energy intake or diet quality between 1994–1996 and 2003–2004. It could be that the 2003–2004 data did not capture the recent increase in healthy FAFH options. As new dietary data become available we need to monitor whether the effect of FAFH on diet quality changes when the commercial food service industry provides nutrition information and healthy menu items.

References

Center for Science in the Public Interest (CSPI), 2003. Anyone’s Guess the Need for Nutrition Labeling at Fast-food and Other Chain Restaurants, Washington, DC.