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Janet Currie, Stefano DellaVigna,
Enrico Moretti, Vikram Pathania

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Janet Currie, Columbia University and NBER
Stefano DellaVigna, UC Berkeley and NBER
Enrico Moretti, UC Berkeley and NBER
Vikram Pathania, UC Berkeley

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Abstract. We investigate the health consequences of changes in the supply of fast food using the exact geographical location of fast food restaurants. Specifically, we ask how the supply of fast food affects the obesity rates of 3 million school children and the weight gain of over 1 million pregnant women. We find that among 9th grade children, a fast food restaurant within a tenth of a mile of a school is associated with at least a 5.2 percent increase in obesity rates. There is no discernable effect at .25 miles and at .5 miles. Among pregnant women, models with mother fixed effects indicate that a fast food restaurant within a half mile of her residence results in a 2.5 percent increase in the probability of gaining over 20 kilos. The effect is larger, but less precisely estimated at .1 miles. In contrast, the presence of non-fast food restaurants is uncorrelated with obesity and weight gain. Moreover, proximity to future fast food restaurants is uncorrelated with current obesity and weight gain, conditional on current proximity to fast food. The implied effects of fast-food on caloric intake are at least one order of magnitude smaller for mothers, which suggests that they are less constrained by travel costs than school children. Our results imply that policies restricting access to fast food near schools could have significant effects on obesity among school children, but similar policies restricting the availability of fast food in residential areas are unlikely to have large effects on adults.

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1. Introduction

The prevalence of obesity and obesity related diseases has increased rapidly in the U.S. since the mid 1970s. At the same time, the number of fast food restaurants more than doubled over the same time period, while the number of other restaurants grew at a much slower pace according to the Census of Retail Trade (Chou, Grossman, and Saffer, 2004). In the public debate over obesity it is often assumed that the widespread availability of fast food restaurants is an important determinant of the dramatic increases in obesity rates. Policy makers in several cities have responded by restricting the availability or content of fast food, or by requiring posting of the caloric content of the meals (Mcbride, 2008; Mair et al. 2005). But the evidence linking fast food and obesity is not strong. Much of it is based on correlational studies in small data sets.

In this paper we seek to identify the causal effect of increases in the supply of fast food restaurants on obesity rates. Specifically, using a detailed dataset on the exact geographical location restaurant establishments, we ask how proximity to fast food affects the obesity rates of 3 million school children and the weight gain of over 1 million pregnant women.

For school children, we observe obesity rates for 9th graders in California over several years, and we are therefore able to estimate cross-sectional as well fixed effects models that control for characteristics of schools and neighborhoods. For mothers, we employ the information on weight gain during pregnancy reported in the Vital Statistics data for Michigan, New Jersey, and Texas covering fifteen years.[1] We focus on women who have at least two children so that we can follow a given woman across two pregnancies and estimate models that include mother fixed effects.

The design employed in this study allows for a more precise identification of the effect of fast-food on obesity compared to the previous literature (summarized in Section 2). First, we observe information on weight for millions of individuals compared to at most tens of thousand in the standard data sets with weight information such as the NHANES and the BRFSS. This substantially increases the power of our estimates. Second, we exploit very detailed geographical location information, including distances

[1] The Vital Statistics data reports only the weight gain and not the weight at the beginning (or end) of the pregnancy. One advantage of focusing on a longitudinal measure of weight gain instead of a measure of weight in levels is that only the recent exposure to fast-food should matter.

of only one tenth of a mile. By comparing groups of individuals who are at only slightly different distances to a restaurant, we can arguably diminish the impact of unobservable differences in characteristics between the two groups. Third, we have a more precise idea of the timing of exposure than many previous studies: The 9th graders are exposed to fast food near their new school from September until the time of a spring fitness test, while weight gain during pregnancy pertains to the 9 months of pregnancy.

While it is clear that fast food is generally unhealthy, it is not obvious a priori that changes in the availability of fast food should be expected to have an impact on health. On the one hand, it is possible that proximity to a fast food restaurant simply leads local consumers to substitute away from unhealthy food prepared at home or consumed in existing restaurants, without significant changes in the overall amount of unhealthy food consumed. On the other hand, proximity to a fast food restaurant could lower the monetary and non-monetary costs of accessing unhealthy food. In addition, proximity to fast food may increase consumption of unhealthy food even in the absence of any decrease in cost if individuals have self-control problems.

Ultimately, the effect of changes in the supply of fast food on obesity is an empirical question. We find that among 9th grade children, the presence of a fast-food restaurant within a tenth of a mile of a school is associated with an increase of about 1.7 percentage points in the fraction of students in a class who are obese relative to the presence at .25 miles. This effect amounts to a 5.2 percent increase in the incidence of obesity. Since grade 9 is the first year of high school and the fitness tests take place in the Spring, the period of fast-food exposure is approximately 30 weeks, implying an increased caloric intake of 30 to 100 calories per school-day. The effect is larger in models that include school fixed effects. Consistent with highly non–linear transportation costs, we find no discernable effect at .25 miles and at .5 miles. The effect is largest for Hispanic students and female students.

Among pregnant women, we find that a fast food restaurant within a half mile of a residence results in 0.19 percentage points higher probability of gaining over 20kg. This amounts to a 2.5 percent increase in the probability of gaining over 20 kilos. The effect is larger at .1 miles, but in contrast to the results for 9th graders, it is still discernable at .25 miles and at .5 miles. The increase in weight implies an increased caloric intake of 1 to 4 calories per day in the pregnancy period. The effect varies across races and educational levels. It is largest for African American mothers and for mothers with a high school education or less. It is zero for mothers with a college degree or an associate's degree.

Overall, our findings suggest that increases in the supply of fast food restaurants have a significant effect on obesity, at least in some groups. However, it is in principle possible that our estimates reflect unmeasured shifts in the demand for fast food. Fast food chains are likely to open new restaurants where they expect demand to be strong, and higher demand for unhealthy food is almost certainly correlated with higher risk of obesity. The presence of unobserved determinants of obesity that may be correlated with increases in the number of fast food restaurants would lead us to overestimate the role of fast food restaurants.

We can not entirely rule out this possibility. However, three pieces of evidence lend some credibility to our interpretation. First, we find that observable characteristics of the schools are not associated with changes in the availability of a fast food in the immediate vicinity of a school. Furthermore, we show that within the geographical area under consideration, fast food restaurants are uniformly distributed over space. Specifically, fast food restaurants are equally likely to be located within .1, .25, and .5 miles of a school. We also find that after conditioning on mother fixed effects, the observable characteristics of mothers that predict high weight gain are negatively (not positively) related to the presence of a fast-food chain, suggesting that any bias in our estimates may be downward, not upward. While these findings do not necessarily imply that changes in the supply of fast food restaurants are orthogonal to unobserved determinants of obesity, they are at least consistent with our identifying assumption.

Second, while we find that proximity to a fast food restaurant is associated with increases in obesity rates and weight gains, proximity to non fast food restaurants has no discernible effect on obesity rates or weight gains. This suggests that our estimates are not just capturing increases in the local demand for restaurant establishments.

Third, we find that while current proximity to a fast food restaurant affects current obesity rates, proximity to *future* fast food restaurants, controlling for current proximity, has no effect on current obesity rates and weight gains. Taken together, the weight of the evidence is consistent with a causal effect of fast food restaurants on obesity rates among 9th graders and on weight gains among pregnant women.

The results on the impact of fast-food on obesity are consistent with a model in which access to fast-foods increases obesity by lowering food prices or by tempting consumers with self-control problems.[2] Differences in travel costs between students and mothers could explain the different effects of proximity. Ninth graders have higher travel costs in the sense that they are constrained to stay near the school during the school day, and hence are more affected by fast-food restaurants that are very close to the school. For this group, proximity to fast-food has a quite sizeable effect on obesity. In contrast, for pregnant women, proximity to fast-food has a quantitatively small (albeit statistically significant) impact on weight gain. Our results suggest that a ban on fast-foods in the immediate proximity of schools could have a sizeable effect on obesity rates among affected students. However, a similar attempt to reduce access to fast food in residential neighborhoods would be unlikely to have much effect on adult consumers.

The remainder of the paper is organized as follows. In Section 2 we review the existing literature. In Section 3 we describe our data sources. In Section 4, we present our econometric models and our empirical findings. Section 5 concludes.

2. Background

While the main motivation for focusing on school children and pregnant women is the availability of geographically detailed data on weight measures for a very large sample, they are important groups to study in their own right. Among school aged children 6-19 rates of overweight have soared from about 5% in the early 1970s to 16% in 1999-2002 (Hedley et al. 2004). These rates are of particular concern given that children who are overweight are more likely to be overweight as adults, and are increasingly suffering from diseases associated with obesity while still in childhood (Krebs and Jacobson, 2003). At the same time, the fraction of women gaining over 60

[2] Consumers with self-control problems are not as tempted by fatty foods if they first have to incur the transportation cost of walking to a fast-food restaurant. Only when a fast-food is right near the school, the temptation of the fast-food looms large. For an overview of the role of self-control in economic applications, see DellaVigna (2009). A model of cues in consumption (Laibson, 2001) has similar implications: a fast-food that is in immediate proximity from the school is more likely to trigger a cue that leads to over-consumption.

pounds during pregnancy doubled between 1989 and 2000 (Lin, forthcoming). Excessive weight gain during pregnancy is often associated with higher rates of hypertension, C-section, and large-for-gestational age infants, as well as with a higher incidence of later maternal obesity (Gunderson and Abrams, 2000; Rooney and Schauberger, 2002; Thorsdottir et al., 2002; Wanjiku and Raynor, 2004).[3] Moreover, Figure 1 shows that the incidence of low APGAR scores (APGAR scores less than 8), an indicator of poor fetal health, increases sharply with weight gain above about 20 kilograms.

Critics of the fast food industry point to several features that may make fast food less healthy than other types of restaurant food (Spurlock, 2004; Schlosser, 2002). These include low monetary and time costs, large portions, and high calorie density of signature menu items. Indeed, energy densities for individual food items are often so high that it would be difficult for individuals consuming them not to exceed their average recommended dietary intakes (Prentice and Jebb, 2003). Some consumers may be particularly vulnerable. In two randomized experimental trials involving 26 obese and 28 lean adolescents, Ebbeling et al. (2004) compared caloric intakes on “unlimited fast food days” and “no fast food days”. They found that obese adolescents had higher caloric intakes on the fast food days, but not on the no fast food days.

The largest fast food chains are also characterized by aggressive marketing to children. One experimental study of young children 3 to 5 offered them identical pairs of foods and beverages, the only difference being that some of the foods were in McDonald’s packaging. Children were significantly more likely to choose items perceived to be from McDonald’s (Robinson et al. 2007). Chou, Grossman, and Rashad (forthcoming) use data from the National Longitudinal Surveys (NLS) 1979 and 1997 cohorts to examine the effect of exposure to fast food advertising on overweight among children and adolescents. In ordinary least squares (OLS) models, they find significant effects in most specifications.[4]

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[3] According to the Centers for Disease Control, obesity and excessive weight gain are independently associated with poor pregnancy outcomes. Recommended weight gain is lower for obese women than in others. (http://www.cdc.gov/pednss/how_to/read_a_data_table/prevalence_tables/birth_outcome.htm)

[4] They also estimate instrumental variables (IV) models using the price of advertising as an instrument. However, while they find a significant “first stage”, they do not report the IV estimates because tests

Still, a recent review of the considerable epidemiological literature about the relationship between fast food and obesity (Rosenheck, 2008) concluded that "Findings from observational studies as yet are unable to demonstrate a causal link between fast food consumption and weight gain or obesity". Most epidemiological studies have longitudinal designs in which large groups of participants are tracked over a period of time and changes in their body mass index (BMI) are correlated with baseline measures of fast food consumption. These studies typically find a positive link between obesity and fast food consumption. However, existing observational studies cannot rule out potential confounders such as lack of physical activity, consumption of sugary beverages, and so on. Moreover, all of these studies rely on self-reported consumption of fast food.[5]

There is also a rapidly growing economics literature on obesity, reviewed in Philipson and Posner (2008). Economic studies place varying amounts of emphasis on increased caloric consumption as a primary determinant of obesity (a trend that is consistent with the increased availability of fast food). Using data from the NLSY, Lakdawalla and Philipson (2002) conclude that about 40% of the increase in obesity from 1976 to 1994 is attributable to lower food prices (and increased consumption) while the remainder is due to reduced physical activity in market and home production. Bleich et al. (2007) examine data from several developed countries and conclude that increased caloric intake is the main contributor to obesity. Cutler et al. (2003) examine food diaries as well as time use data from the last few decades and conclude that rising obesity is linked to increased caloric intake and not to reduced energy expenditure.[6] [7]

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suggest that advertising exposure is not endogenous. They also estimate, but do not report individual fixed effects models, because these models have much larger standard errors than the ones reported.

[5] A typical question is of the form "How often do you eat food from a place like McDonald's, Kentucky Fried Chicken, Pizza Hut, Burger King or some other fast food restaurant?"

[6] They suggest that the increased caloric intake is from greater frequency of snacking, and not from increased portion sizes at restaurants or fattening meals at fast food restaurants. They further suggest that technological change has lowered the time cost of food preparation which in turn has lead to more frequent consumption of food. Finally, they speculate that people with self control problems are over-consuming in response to the fall in the time cost of food preparation. Cawley (1999) discusses a similar behavioral theory of obesity as a consequence of addiction.

[7] Courtemanche and Carden examine the impact on obesity of Wal-Mart and warehouse club retailers such as Sam's club, Costco and BJ's wholesale club which compete on price. They link store location data to individual data from the Behavioral Risk Factor Surveillance System (BRFSS.) They find that non-grocery selling Wal-Mart stores reduce weight while non-grocery selling stores and warehouse clubs either reduce weight or have no effect. Their explanation is that reduced prices for everyday purchases expand real

A series of recent papers explicitly focus on fast food restaurants as potential contributors to obesity. Chou et al. (2004) estimate models combining state-level price data with individual demographic and weight data from the Behavioral Risk Factor Surveillance surveys and find a positive association between obesity and the per capita number of restaurants (fast food and others) in the state. Rashad, Grossman, and Chou (2005) present similar findings using data from the National Health and Nutrition Examination Surveys. Anderson and Butcher (2005) investigate the effect of school food policies on the BMI of adolescent students using data from the NLSY97. They assume that variation in financial pressure on schools across counties provides exogenous variation in availability of junk food in the schools. They find that a 10 percentage point increase in the probability of access to junk food at school can lead to about 1 percent increase in students' BMI. Anderson, Butcher and Schanzenbach (2007) examine the elasticity of children's BMI with respect to mother's BMI and find that it has increased over time, suggesting an increased role for environmental factors in child obesity. Anderson, Butcher, and Levine (2003) find that maternal employment is related to childhood obesity, and speculate that employed mothers might spend more on fast food. Cawley and Liu (2007) use time use data and find that employed women spend less time cooking and are more likely to purchase prepared foods.

The paper that is closest to ours is a recent study by Anderson and Matsa (2009) that focuses on the link between eating out and obesity using the presence of Interstate highways in rural areas as an instrument for restaurant density. Interstate highways increase restaurant density for communities adjacent to highways, reducing the travel costs of eating out for people in these communities. They find no evidence of a causal link between restaurants and obesity. Using data from the USDA, they argue that the lack of an effect is due to the presence of selection bias in restaurant patrons –people who eat out also consume more calories when they eat at home--and the fact that large portions at restaurants are offset by lower caloric intake at other times of the day.

Our paper differs from Anderson and Matsa (2009) in four important dimensions, and these four differences are likely to explain the difference in our findings.

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incomes, enabling households to substitute away from cheap unhealthy foods to more expensive but healthier alternatives.

(i) First, our data allow us to distinguish between fast food restaurants and other restaurants. We can therefore estimate separately the impact of fast-foods and of other restaurants on obesity. In contrast, Anderson and Matsa do not have data on fast food restaurants and therefore focus on the effect of *any* restaurant on obesity. This difference turns out to be crucial, because when we estimate the effect of any restaurant on obesity using our data we also find no discernible effect on obesity.

(ii) Second, we have a very large sample that allows us to identify even small effects, such as mean increases of 50 grams in the weight gain of mothers during pregnancy. Our estimates of weight gain for mothers are within the confidence interval of Anderson and Matsa's two stage least squares estimates. Put differently, based on their sample size, our statistically significant estimates would have been considered statistically insignificant.

(iii) Third, our data give us the exact location of each restaurant, school and mother. The spatial richness of our data allows us to examine the effect of fast food restaurants on obesity at a very detailed geographical level. For example, we can distinguish the effect at .1 miles from the effect at .25 miles. As it turns out, this feature is quite important, because the effects that we find are geographically extremely localized. For example, we find that fast food restaurant have an effect on 9th graders only for distances of .1 miles or less. By contrast, Anderson and Matsa use a city as the level of geographical analysis. It is not surprising that at this level of aggregation the estimated effect is zero.

(iv) Fourth, Anderson and Matsa's identification strategy differs from ours, since we do not use an instrument for fast-food availability and focus instead on changes in the availability of fast-foods at very close distances. The populations under consideration are also different, and may react differently to proximity to a fast food restaurant. Anderson and Matsa focus on predominantly white rural communities, while we focus on primarily urban 9th graders and urban mothers. We document that the effects vary considerable depending on race, with blacks and Hispanics having the largest effect. Indeed, when Dunn (2008) uses an instrumental variables approach similar to the one used Anderson and Matsa based on proximity to freeways, he finds no effect for rural areas and for whites in suburban areas, but strong effect for blacks and Hispanics. As we show below, we also find stronger effects for minorities.

Taken together, these four differences lead us to conclude that the evidence in Anderson and Matsa is consistent with our evidence.[8]

In summary, there is strong evidence of correlations between fast food consumption and obesity. It has been more difficult to demonstrate a *causal* role for fast food. In this paper we tap new data in an attempt to test the causal connection between fast food and obesity.

3. Data Sources and Summary Statistics

Data for this project comes from three sources.

(a) School Data. Data on children comes from the California public schools for the years 1999 and 2001 to 2007. The observations for 9th graders, which we focus on in this paper, represent 3.06 million student-year observations. In the spring, California 9th graders are given a fitness assessment, the FITNESSGRAM®. Data is reported at the class level in the form of the percentage of students who are obese, and who have acceptable levels of abdominal strength, aerobic capacity, flexibility, trunk strength, and upper body strength. Obesity is measured using actual body fat measures, which are considerably more accurate than the usual BMI measure (Cawley and Burkhauser, 2006). Data is also reported for sub-groups within the school (e.g. by race and gender) provided the cells have at least 10 students. Since grade 9 is the first year of high school and the fitness tests take place in the Spring, this impact corresponds to approximately 30 weeks of fast-food exposure.[9]

This administrative data set is merged to information about schools (including the percent black, white, Hispanic, and Asian, percent immigrant, pupil/teacher ratios, fraction eligible for free lunch etc.) from the National Center for Education Statistic's Common Core of Data, as well as to the Start test scores for the 9th grade. The location of the school was also geocoded using ArcView. Finally, we merged in information

[8] See also Brennan and carpenter (2009).

[9] In very few cases, a high school is in the same location as a middle school, in which case the estimates reflect a longer-term impact of fast-food.

about the nearest Census block group of the school from the 2000 Census including the median earnings, percent high-school degree, percent unemployed, and percent urban.

(b) **Mothers Data.** Data on mothers come from Vital Statistics Natality data from Michigan, New Jersey, and Texas. These data are from birth certificates, and cover all births in these states from 1989 to 2003 (from 1990 in Michigan). For these three states, we were able to gain access to confidential data including mothers names, birth dates, and addresses, which enabled us both to construct a panel data set linking births to the same mother over time, and to geocode her location (again using ArcView). The Natality data are very rich, and include information about the mother's age, education, race and ethnicity; whether she smoked during pregnancy; the child's gender, birth order, and gestation; whether it was a multiple birth; and maternal weight gain. We restrict the sample to singleton births and to mothers with at least two births in the sample, for a total of over 3.5 million births.

(c) **Restaurant Data.** Restaurant data with geo-coding information come from the National Establishment Time Series Database (Dun and Bradstreet). These data are used by all major banks, lending institutions, insurance and finance companies as the primary system for creditworthiness assessment of firms. As such, it is arguably more precise and comprehensive than yellow pages and business directories.[10] We obtained a panel of virtually all firms in Standard Industrial Classification 58 from 1990 to 2006, with names and addresses. Using this data, we constructed several different measures of "fast food" and "other restaurants," as discussed further in Appendix 1. In this paper, the benchmark definition of fast-food restaurants includes only the top-10 fast-food chains, namely, Mc Donalds, Subway, Burger King, Taco Bell, Pizza Hut, Little Caesars, KFC, Wendy's, Dominos Pizza, and Jack In The Box. We also show estimates using a broader definition that includes both chain restaurants and independent burger and pizza restaurants. Finally, we also measure the supply of non-fast food restaurants. The definition of "other restaurants" changes with the definition of fast food. Appendix Table 1 lists the top 10 fast food chains as well as examples of restaurants that we did not classify as fast food.

[10] The yellow pages are not intended to be a comprehensive listing of businesses - they are a paid advertisement. Companies that do not pay are not listed.

Matching. Matching was performed using information on latitude and longitude of restaurant location. Specifically, we match the schools and mother's residence to the closest restaurants using ArcView software. For the school data, we match the results on testing for the spring of year *t* with restaurant availability in year *t-1*. For the mother data, we match the data on weight gain during pregnancy with restaurant availability in the year that overlaps the most with the pregnancy.

Summary Statistics. Using the data on restaurant, school, and mother's locations, we constructed indicators for whether there are fast food or other restaurants within .1, .25, and .5 miles of either the school or the mother's residence. Table 1a shows summary characteristics of the schools data set by distance to a fast food restaurant. Here, as in most of the paper, we use the narrow definition of fast-food, including the top-10 fast-food chains. Relatively few schools are within .1 miles of a fast food restaurant, and the characteristics of these schools are somewhat different than those of the average California school. Only 7% of schools have a fast food restaurant within .1 miles, while 65% of all schools have a fast food restaurant within 1/2 of a mile.[11] Schools within .1 miles of a fast food restaurant have more Hispanic students, a slightly higher fraction of students eligible for free lunch, and lower test scores. They are also located in poorer and more urban areas. The last row indicates that schools near a fast food restaurant have a higher incidence of obese students than the average California school.

Table 1b shows a similar summary of the mother data. Again, mothers who live near fast food restaurants have different characteristics than the average mother. They are younger, less educated, more likely to be black or Hispanic, and less likely to be married.

4. Empirical Analysis

We begin in Section 4.1 by describing our econometric models and our identifying assumptions. In Section 4.2 we show the correlation between restaurant location and student characteristics for the school sample, and the correlation between

[11] The average school in our sample had 4 fast foods within 1 mile and 24 other restaurants within the same radius.

restaurant location and mother characteristics for the mother sample. Our empirical estimates for students and mothers are in Section 4.3 and 4.4, respectively.

4.1 Econometric Specifications

Our empirical specification for schools is

$$(1)\quad Y_{st} = \alpha\, F1_{st} + \beta\, F25_{st} + \gamma\, F50_{st} + \alpha'\, N1_{st} + \beta'\, N25_{st} + \gamma'\, N50_{st} + \delta\, X_{st} + \theta\, Z_{st} + d_s + e_{st}$$

where Y_{st} is the fraction of students in school *s* in a given grade who are obese in year *t*; $F1_{st}$ is an indicator equal to 1 if there is a fast food restaurant within .1 mile from the school in year *t*; $F25_{st}$ is an indicator equal to 1 if there is a fast food restaurant within .25 miles from the school in year *t*; $F50_{st}$ is an indicator equal to 1 if there is a fast food restaurant within .5 mile from the school in year *t*; $N1_{st,}$ $N25_{st}$ and $N50_{st}$ are similar indicators for the presence of non-fast food restaurants within .1, .25 and .5 miles from the school; d_s is a fixed effect for the school.

The vectors X_{st} and Z_{st} include school and neighborhood *time-varying* characteristics that can potentially affect obesity rates. Specifically, X_{st} is a vector of school-grade specific characteristics including fraction blacks, fraction native Americans, fraction Hispanic, fraction immigrants, fraction female, fraction eligible for free lunch, whether the school is qualified for Title I funding, pupil/teacher ratio, and 9th grade tests scores, as well as school-district characteristics such as fraction immigrants, fraction of non-English speaking students (LEP/ELL), share of IEP students. Z_{st} is a vector of characteristics of the Census block closest to the school including median income, median earnings, average household size, median rent, median housing value, percent white, percent black, percent Asian, percent male, percent unmarried, percent divorced, percent with a high school degree, percent with an associate degree, percent with college degree, percent with a post-graduate degree, percent in the labor force, percent employed, percent with household income under \$10,000, percent with household income above \$200,000, percent urban, percent of the housing stock that is owner occupied. To account for heteroskedasticity caused by the fact that cells vary in size, we weight all our models by the number of students in each cell. To account for the possible correlation of the residual e_s within a school, we report standard errors clustered by school.

In the cross-sectional specification without school fixed effects *d,* the identification of the effect of fast food on student obesity rates arises from relating obesity rates for 9th grade students in a given school to indicators for the presence of fast food restaurants at different distances to the school, conditional on the controls. In the specification with school fixed effects, identification depends on changes in obesity rates for schools that experience a change in fast-food presence. In this latter specification, while the sample includes all schools, only schools that experience a change in the proximity of fast food restaurants effectively contribute to the estimation of the parameters α, β and γ. In either specification, the key identifying assumption is that after conditioning on the vectors X and Z, and on the proximity of non-fast food restaurants (as well as on the school effects in the fixed effect specification), the non fast food determinants of obesity are not systematically correlated with proximity to fast food restaurants. In sub-section 4.2 below we report some evidence intended to probe the validity of this assumption.

The fast food indicators $F1_{st}$, $F25_{st}$ and $F50_{st}$ are not mutually exclusive. Similarly, we define the non-fast food indicators $N1_{st}$, $N25_{st}$ and $N50_{st}$ as not mutually exclusive. This means that the coefficient α, for example, is the difference in the effect of having a fast food restaurant within .1 mile and the effect of having a fast food restaurant within .25 miles. This implies that to compute the effect of having a fast food restaurant within .1 mile one needs to sum the three coefficients α+β+γ. In some models, we report a more parsimonious specification where only dummies for fast food closer than .1 miles are included:

(2) $$Y_{st} = \alpha\, F1_{st} + \alpha'\, N1_{st} + \delta\, X_{st} + \theta\, Z_{st} + d_s + e_{st}$$

When we use our sample of mothers, our econometric specification is

(3) $$Y_{it} = \alpha\, F1_{it} + \beta\, F25_{it} + \gamma\, F50_{it} + \alpha'\, N1_{it} + \beta'\, N25_{it} + \gamma'\, N50_{it} + \delta\, X_{it} + d_i + e_{it}$$

where Y_{it} is either an indicator equal 1 if mother *i* gains more than 20Kg during her *t*th pregnancy or mother *i*'s weight gain during her *t*th pregnancy; X_{it} is a vector of time-varying mother characteristics that may affect weight gain including age dummies, four dummies for education, dummies for race, Hispanic status, an indicator equal to 1 if the mother smokes during pregnancy, and indicator for male child, dummies for parity, marital status and year dummies;[12] and d_i is a mother fixed effect. To account for the possible correlation of the residual e_{it} for the same individual over time, we report standard errors clustered by mother.

In an alternative set of specifications we include fixed effects for the zip code of residence of the mother rather than mother fixed effects. This specification is similar to the fixed effect specification for the schools.

The key identifying assumption is that after conditioning on individual (or zip code) fixed effects, the vector X, and the proximity of non-fast food restaurants, changes in other determinants of obesity rates are not systematically correlated with changes in the proximity of fast food restaurants. Below we report some tests of this assumption.

One concern is the possible presence of measurement error. While our information about restaurants comes from one of the most reliable existing data sources on the location of retailers[13], it is probably not immune from measurement error. While measurement error in equations 1 to 4 is not necessarily classical, it is unlikely to results in overestimates of the true effect. Our empirical findings point to an effect of fast food restaurants on obesity that declines with distance. In this setting, it is unlikely that the true effect is zero, and that measurement error alone is responsible for our empirical finding. First, measurement error is more likely to induce some attenuation bias in our estimates (i.e. a downward bias). Second, even if measurement error did not induce downward bias, it would have to vary systematically with distance, and there is no obvious reason why this would be the case.[14]

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[12] Also included are indicators for missing education, race, Hispanic status, smoking and marital status.

[13] Our data on restaurant are considered by some as the "best data source for studying business location" (Kolko and Neumark, 2008).

[14] As an additional check, we used Google Map to check the distance between schools and restaurants for a random sample of our schools. This comparison is complicated by three problems. First, Google Map data are not immune from measurement error. In our search, we found some instances in which Google Map significantly misreported or missed the location of a business. Second, our data end in mid-2006, while current Google Maps reflect restaurant location at the end of 2008. There is considerable churning in this industry, so even if our data and Google data were perfectly correct, we could find some discrepancies. Third, our measure of distance is "as the crow flies", while Google Map only provides driving distance. This latter issue is a problem because the key variable of interest for us is a dummy equal to 1 if the

4.2 Correlates of Obesity and Fast Food Placement

In columns 1 and 2 of Table 2A, Panel A we begin documenting the observable characteristics of students that are associated with higher risk of obesity. Entries are estimates from models where the dependent variable is the percentage of students in the 9th grade who are classified as obese. The independent variables are all the school-level and Census controls X_{st} and Z_{st}; the Table displays the coefficient for key select variables. The unit of observation is a school-grade-year for schools in California in the years 1999 and 2001-2007. Standard errors clustered by school are shown in parenthesis.

Column 1 indicates that the share of African American students and Hispanic students are positively associated with higher obesity rates. Average test scores are strongly negatively associated with obesity. Column 2 indicates that conditional on school fixed effects, the correlations between obesity and Hispanic status, and between obesity and test scores remain largely significant. In column 2, the share of Asian students is negatively statistically significant.

To investigate the plausibility of our identifying assumptions, we ask whether observable characteristics of students (mothers) are associated with levels of (and changes in) the availability of a fast food near a school (her residence). Columns 3 to 8 explore the correlation between observable student characteristics and availability of fast food restaurants. Specifically, the dependent variables in columns 3-8 are indicator variables for the presence of at least one fast-food restaurant within a given distance from the school. Models in columns 3 to 5 control for school characteristics and Census block characteristics. Models in columns 6 to 8 also include school fixed effects. In both cases, we include a control for the availability of non-fast-food restaurants at the same distance, since this control is also present in our main specifications.

In the cross-sectional specifications (columns 3 to 5) the most important determinant of fast-food availability is the presence of a non-fast-food restaurant, followed by urban status. The racial composition and the average test scores in the

distance between the school and the restaurant is <.1 miles. Even small differences between distance measured "as the crow flies" and driving distance may lead us to incorrectly label our indicator as incorrect, when in fact it is correct. In the sub-sample of 30 schools that we checked by hand, we estimate a reliability ratio of .75. Given the three limitations described above, we consider this evidence as quite encouraging.

school, which are strong predictors of obesity, do not predict fast-food availability instead. Indeed, the full set of demographic controls X and Z is not jointly significant in the regressions predicting the availability of fast-food at the .25 miles or 1. mile distance (although they are at .5 miles distance). This finding stands in stark contrast to the strong effect that the demographic controls have on the obesity measure (columns 1 and 2). If selection on observable variables is similar to selection on unobservable variables (as in Altonji, Elder and Taber, 2005), this finding indicates that cross-sectional models that condition on our controls should yield consistent estimates.

To elaborate on this idea, in Panel B we generate the best linear predictor of the share of obese students using the full set of controls X and Z. We then regress the indicator variables for the availability of a fast-food restaurant on this predicted share of obese students and on a control for the availability of other restaurants. The coefficient on the predicted variable indicates how much fast-food availability loads on the same observables that predict obesity. If this variable loads positively, it indicates that the same variables that predict obesity also predict fast-food availability, indicating the potential for a spurious positive correlation between fast-food and obesity. We find that, while this obesity predictor is significantly correlated with availability of fast-food within .5 miles of a school, it is not correlated with the availability of fast-food at closer distances (.25 miles or .1 mile). This indicates that selection on unobservables may not be an important concern at short distances.

We perform a similar analysis for the fixed effect specifications (columns 6 to 8). As in the cross-section, we cannot reject the hypothesis that the demographic controls X and Z are jointly insignificant in the regressions predicting fast-food availability within .25 miles or within .1 miles of a school. In addition, we find no evidence that the predicted share of obese students (Panel B) correlates with the availability of fast-food. These results suggest that in the fixed effect specification the observables that determine obesity rates are not significant determinants of fast-food availability, allaying some of the concerns about endogeneity of the fast-food measure.

In panel C, we ask whether fast food restaurants are more likely to be located in the immediate vicinity of a school, i.e. within .1 miles from a school as opposed to within .25 or .5 miles. Specifically, we test for whether fast food restaurant are geographically uniformly distributed in the area around schools. If they are, we expect the number of fast-foods within .25 (respectively, .5) miles of a school to be 2.5^2 (respectively, 5^2) larger than the number of fast-foods within .1 mile of a school. To make the test clearer and more conservative, we do not condition on the controls that we use in the regressions. The results at the bottom of table 2A indicate that we cannot reject the null hypothesis of uniform placement of fast-foods at either horizon. While the placement of fast-foods may still be endogenous when comparing availability at longer distances, at the close distances that we consider in this paper we find no evidence of endogenous placement.

Overall, we find no systematic evidence of an effect of demographic controls on fast-food availability at very close distance from a school. While this finding does not necessarily imply that changes in the supply of fast food restaurants are orthogonal to unobserved determinants of obesity, it is at least consistent with our identifying assumption.

Table 2B reports a similar investigation for the mother sample. Here we report standard errors clustered by zip code or by mother in parenthesis. Column 1 and Columns 3 to 5 in Panel A report estimates from a model with zip code fixed effects. African American and Hispanic mothers are less likely to gain over 20kg during pregnancy, but more likely to have a fast-food establishment present near them. These variables suggest a negative correlation between the determinants of fast-food availability and high weight gain. The pattern differs for smoking and marriage status. Smoking is positively related to both high weight gain and fast-food availability, while the opposite is true for being married. These variables suggest a positive correlation between the determinants of fast-food availability and high weight gain.

In Panel B, we present the results of the summary measure of predicted weight gain constructed by estimating a probit model of high weight gain on the observables.[15] computing the best linear predictor of weight gain given the observables. Column 3 indicates that mothers who, based on their observable characteristics, have a high probability of high weight gain are also more likely to be located near a fast food restaurant, after conditioning on the availability of non fast food restaurant within .5

[15] These include age dummies, dummies for education, and indicators for race, Hispanic ethnicity, maternal smoking, male child, and marital status, as well as indicators for parity and year dummies.

miles and zip code fixed effects. The coefficient on the predicted probability of gaining more than 20kg declines substantially when we condition on the availability of non-fast food restaurants within .25 miles and zip code fixed effects (column 4). It declines even further when we condition on the availability of non fast food restaurant within .1 miles and zip code fixed effects (column 5), although it remains statistically significant. This indicates that better controls for the availability of other restaurants reduce but do not eliminate the extent of selection on observables.

In columns 2 and 6 to 8 we consider the same patterns for models with mother fixed effects. The coefficient on the predicted probability of weight gain above 20kg is negative for fast-food availability at .5 miles (column 6), but it declines to zero when we condition on the number of non fast food restaurants within .1 miles and mother fixed effects (column 8). This is reassuring, because it implies that after controlling for mother fixed effects and availability of non-fast food restaurants, the observable characteristics of the mothers in our sample would predict an average or lower than average probability of weight gain > 20Kg. While we can not rule out the possibility that selection on unobservables is completely different from selection on observables, Table 2B is consistent with our identifying assumption that location of fast food restaurants is not associated with other unobserved determinants of obesity, after conditioning on mother fixed effects.

4.3 Empirical Results for Schools

In this sub-section we present estimates of the effect of fast food on obesity based on the sample of California schools. In the next sub-section, we present estimates of the effect of fast food on obesity based on the mother sample.

(**a) Baseline Estimates.** Table 3 shows our baseline empirical estimates of the effect of changes in the supply of fast food restaurants on obesity rates, equation 1. The dependent variable is the percentage of students in the 9th grade who are classified as obese. Each column is from a different regression. Entries in rows 1, 3 and 5 are the coefficient on a dummy for the existence of a fast food restaurant at a given distance from the school. These entries are estimates of coefficients α, β and γ in equation 1. Entries in rows 2, 4 and 6 are coefficients on dummy for the existence of a non-fast food restaurant at a given distance from the school. These entries are estimates of coefficients α', β' and γ' in equation 1.

For completeness, in column 1 we report unconditional estimates. There is a positive association between availability of a fast food within .5 miles and obesity rates, but the coefficient is not statistically significant. Recall that the fast food and non-fast food indicators are not mutually exclusive, so that to obtain the effect of availability of a fast food within .25 miles one needs to add the coefficients on $F50_s$ and $F25_s$: 1.3903-2.4859= -1.0956. Similarly, the effect of the availability of a fast food within .1 miles is the sum of three coefficients 1.3903-2.4859 +3.0807 = 1.9851.

Estimates in column 2 condition on school level controls, census block controls and year effects. Here the only statistically significant effect is associated with the availability of a fast food restaurant within .1 miles. The coefficients on availability of fast food within .25 miles and availability of fast food within .50 miles become insignificant because their point estimates decline, not because the standard errors increase. If anything, standard errors are smaller in column 2 than in column 1, indicating that our controls do a good job absorbing other determinants of obesity but leave enough variation for the identification of the effect of interest.

While increases in the number of fast food restaurants within .1 mile result in increases in obesity rates, increases in the number of non-fast food restaurants have no effect on obesity. This is reassuring, since it suggests that the increases in obesity are not driven by unobserved shifters in the overall demand for restaurants in an area.

How large is the estimated effect? Column 2 indicates that the presence of a fast food within .1 miles from a school results in a 1.7 percentage point increase in the incidence of obesity for 9th graders relative to the presence of a fast food .25 miles away.[16] This estimate is both statistically significant and economically important. In particular, since the mean of the dependent variable is 32.9, our estimate implies that a fast food within .1 miles from a school results in a 5.2 percent increase in the incidence of obesity. This pattern of effects is consistent with a non linear increase of transportation

[16] Alternatively, a fast food within .1 miles from a school results in a .81 percentage point increase in the incidence of obesity for 9th graders in that school: .81 = 1.7385-.891-.0391.

costs with distance, and/or with strong psychological effects of the availability of fast food restaurants, such as temptation for consumers with self-control problems.

Finally, in column 3 we present estimates with school fixed effects. By including indicators for each school, we completely absorb any time-invariant determinant of obesity. The estimates are identified only by schools where fast-food availability varies over time. At the .1 mile distance, for example, there are 13 schools that add a fast-food, 8 that lose a fast-food, and 1 school that does both.[17] The estimates with school fixed effects point to a statistically significant effect of the availability of a fast food within .1 miles, as in the cross-sectional specification of column 2. While the point estimate in column 3 is larger than the one in column 2, the difference is not statistically significant. There is no evidence of a positive additional effect of the availability of a fast food within .25 miles or .5 miles.

(b) Magnitude of the Estimated Effect. Are the estimated effects plausible? To investigate this question, we compute how many calories it would take per school day to move a 14-year old boy of median height across different cut-offs for overweight status and obesity. If the person at the 80th percentile of BMI moves to the 85th percentile, which is the cutoff for overweight, this corresponds to about a 5% increase in the fraction overweight. Based on CDC (2000) growth charts, it takes only a weight gain of 3.6 pounds to move from the 80th to the 85th percentile of the BMI distribution. Over a period of 30 weeks[18], this corresponds to a gain of about 80 additional calories per school day. Similarly, it would take 300 additional calories to move from the 90^{h} to the 95th percentile of BMI, where the later is the cutoff for obesity.

Based on these calibrations, our cross-sectional estimate of a 1.7 percentage point increase in the obesity rate due to immediate proximity to a fast-food (column 2) corresponds to about 30 additional calories per day according to the first calculation and 100 calories per day according to the second one. These amounts can be compared with

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[17] At the .25 (respectively, .5) mile distance, 63 (respectively, 117) schools switch fast-food availability in the sample.

[18] 30 weeks is the average length of time that the 9th graders are exposed to a nearby restaurant between the beginning of high school in Sept. and the fitness test. BMI percentiles and median height for 14 year old boys are taken from the CDC(2000) growth charts available from www.cdc.gov/nchs/data/nhanes/growthcharts/set1/all.pdf.

the calories from a typical meal at a fast food restaurant, such as 540 calories for MacDonald's Big Mac, 990 calories for Burger King's Double Whopper, 570 for MacDonald's regular fries, and 200 calories for a 16 ounce regular Coke.[19] Even assuming that a large portion of the calories consumed in fast-food restaurants are offset by lower consumption in other meals, it is easy to obtain caloric intake increases that are consistent with the observed effects. The estimates in Table 3 appear therefore quite plausible.

(c) Additional Specifications. In Table 4 we present estimates from a variety of alternative specifications. Columns 1 and 2 show estimates of equation 2. Unlike the estimates of equation 1 shown in Table 5, here we do not control for availability of restaurants more than .1 miles away. In this specification, we compare the exposure to fast-food at .1 mile to exposure at any other distance, instead of comparing to exposure at .25 miles as in Table 3. The point estimate of the effect of fast-food exposure is 1.1 percentage points in the cross-sectional specification (column 1, not significant) and 4.6 percentage points in the panel specification (column 3, marginally significant).

For the remaining specifications in Table 4, we focus on the benchmark cross-sectional specification of Table 3, Column 2. We report only the coefficient on the availability of fast-food and other restaurants at a .1 mile distance. The coefficients on the other distances are not significantly different from zero. Column 3 of Table 4 investigates whether the availability of two or more fast foods within .1 miles has a greater impact than the availability of one fast food within .1 miles. We do not find an additional significant effect of 2 or more restaurant over and above the effect of the first restaurant, which is not surprising given the small number of cases with two or more fast-foods at close distance. Turning to column 4, controlling for the continuous variable indicating the number of non-fast food restaurants within .1 from the school does not affect the estimates on the fast-food variable.

Column 5 investigates whether using a broader definition of fast food changes our main results. The broad definition is based on the Wikipedia list of fast food chains as

[19] The fast food calories are available from http://www.acaloriecounter.com/fast-food.php The estimate that it takes 3500 extra calories per week to gain a pound is from the CDC and is available from http://www.cdc.gov/nccdphp/dnpa/healthyweight/index.htm

described above. Column 5 indicates that the Wikipedia measure does not have any additional impact over and above our baseline definition, suggesting that the top 10 fast foods are qualitatively different from other restaurant chains. Column 4 in Appendix Table 1, which lists the top 10 largest chains according to this definition, shows that indeed these establishments (such as Starbucks and Jamba Juice) are indeed quite different. In column 6 we examine another robustness check by excluding Subway restaurants, which are arguably healthier than the other chains, from our list of top 10 fast food restaurants. The results are essentially the same as using the benchmark definition.

Column 7 shows estimates of a model in which we do not distinguish between fast food and non-fast food restaurants. The key independent variable here is an indicator equal to 1 for any restaurant. This specification is similar to the one used by Anderson and Matsa (2009). Consistent with their findings, we find no evidence that the presence of any restaurant affects obesity.

Finally, columns 8 to 10 show estimates based on models that use different identification strategies. Column 8 reports results from an optimal trimming model, where we include only schools that have a propensity score between .1 and .9. This specification effectively drops observations that are unlikely to be good controls. Column 9 reports estimates based on nearest neighborhood matching, where we match on all the school level and block level covariates. Column 10 reports estimates of a model using the subsample of schools that are within .25 miles of a fast food restaurant. In this regression, the schools with a fast-food within .1 mile are compared to schools with a fast-food within .25 miles, which are arguably very comparable. Across these three specifications, we find similar estimates of the impact of fast-food on the share of obese students, indicating an increase of about 2 percentage points.[20]

In summary, Table 4 indicates that our results are robust to changes in the sample, definition of the key independent variable, and changes in the identification strategy.

(d) Placebo Analysis. One concern with the estimates in Table 3 and 4 is that even after conditioning on school fixed effects and time varying student and neighborhood characteristics, the location of fast food restaurant may still be associated

[20] We also estimated unweighted models, and the results (available on request) are similar.

with other determinants of obesity that we can not control for. After all, fast food chains do not open restaurants randomly. Presumably, they open new restaurants in areas where they expect demand for fast food to be strong.

In Table 5, we test whether we see any evidence of changes in obesity rates as a function of *future* fast food restaurant locations and *past* fast-food locations. If fast food restaurants open in areas that experience unobserved upward trends in demand for fast food, it is possible that current obesity rates may be correlated with future (or lagged) fast food restaurants availability. Otherwise, we expect that future fast-food exposure should not affect obesity rates. Similarly, lagged fast-food presence near the school should not affect obesity rates since students in 9th grade are typically starting high-school in a different location from where they attended middle school. We include availability in year *t* and in year *t+3* (*t-3*) of restaurants (fast-food and not) within .1 miles, as well as the availability in year *t* of restaurants (fast-food and not) within .25 and .5 miles (coefficient not reported in the Table).[21]

Our findings in column 1 indicate that conditional on availability of fast food restaurants in year *t*, availability in year *t+3* does not appear to be positively correlated with obesity rates. If anything, the coefficient on availability of fast food restaurants 3 years later is *negative*, although not statistically significant at conventional levels. Of course, since availability of fast food restaurants now and in 3 years is highly correlated, standard errors are fairly large. In column 2 we restrict the sample to schools that currently do not have a fast food restaurant within .1 miles. For these schools, the opening of a fast food restaurant 3 years later has virtually no correlation with current obesity rates.

In Column 3 we report the results of the exposure to lagged fast-food. We do not find any significant effect of fast-food presence within .1 mile of the school 3 years prior, even though the estimates are noisy and the contemporaneous effect is no longer significant.

(e) Race and Gender Differences in the Obesity Effect. The data on body mass index are available by race and gender group in each reporting school in California as

[21] The results are similar if we use as placebo the availability of fast-food 2 years ahead and 2 years earlier.

long as the relevant group is larger than 10 students in the grade-school-year cell. In Table 6, we split the sample by race and gender. One limitation is that the rule that restricts reporting to groups with at least 10 students induces censoring that varies by demographic group. This is particularly a concern for the group of African American students, since the number of African American residents in California is limited. We report estimates of models similar to equation 2 for the cross-sectional specification (upper panel) and for the panel specification (lower panel).

Column 1 indicates that estimates for whites are not very different from estimates based on the entire sample, although they are slightly less precise. The point estimates are similar for Hispanic students (larger in the fixed effect estimates) and smaller and not significant for African American students.

When we turn to gender differences, we find that the effect is substantially larger for female students than for male students. This gender difference is particularly large for fixed effects models in the lower panel.

An important question is whether the obesity effect is larger for students with low family income. While we do not have a direct measure of income, we tested for differences in the obesity effect by free lunch status. Students who receive free lunch have lower family income than students who do not receive free lunch. In results not shown in the table, we find that the difference in the effects for the two groups is small and not statistically significant at conventional levels.

(e) Detailed Fitness Measures. For completeness, in Appendix Table A2, we report the effect of fast food restaurants on more detailed measures of fitness. We estimate empirical models similar to equation 2, without school fixed effects (upper panel) and with school fixed effects (lower panel). For convenience, column 1 reproduces our baseline obesity estimates from columns 2 and 3 of Table 5. The remaining columns report estimates of models where the dependent variable is abdominal strength (column 2), aerobic capacity (column 3), flexibility (column 4), trunk strength (column 5) and upper body strength (column 6). Cross-sectional estimates in the upper panel point to a negative effect of fast food restaurant on flexibility. However, estimates that condition on fixed effects are generally insignificant.

4.4 Empirical Results for Mothers

(a) Baseline Estimates. We now turn to estimates based on our birth certificate data. Table 7 presents our estimates of equation 3. The dependent variable in columns 1 and 2 is an indicator equal to 1 if weight gain is above 20Kg. The dependent variable in columns 3 and 4 is weight gain in kilograms.

Models that condition on mother fixed effects (columns 2 and 4) point to a positive effect of fast food on weight gain and on the probability of weight gain above 20 kg. The coefficient on the indicator for fast food within .5 miles points to an increase of .19 percentage points in the probability of weight gain larger than 20kg (column 2), and an increase of 0.049kg in weight gain (column 4). These effects correspond to a 1.5 percent and a 0.3 percent increase in the probability of weight gain above 20 kg and in weight gain, respectively.

The point estimates suggest a larger effect at .25 miles and again at .1 miles, however the marginal increments from .50 to .25 and from .25 to .1 are not very precisely estimated. As in the school sample, we find no evidence that non-fast food restaurants are associated with positive effects on weight gain. In fact, Column 3, which includes only zip code fixed effects rather than mother fixed effects, reports negative impacts, but these disappear when mother fixed effects are added to the model, as shown in Column 4, suggesting that it is important to control for unobserved characteristics of mothers.

Compared with our results for students, the effect of fast food availability for mothers is more linear in distance. For 9^{th} graders the effect of distance is highly non-linear. Only availability of fast food within .1 miles seems to matter, and fast food restaurants further away have no discernible impact. For mothers, distance matters, but less discontinuously. The point estimates suggest that the availability of a fast food at .1 mile has a larger impact on mothers than availability at .25, and an even larger effect than availability at .50 miles. This is consistent with 9^{th} graders having higher transportation costs than mothers or less self-control.

(b) Magnitude of the Estimated Effect. The estimated effect of exposure to fast-food restaurants at a .5 mile distance is to increase the weight gain of mothers during pregnancy by 49 grams (Table 7, Column 4 with mother fixed effects). Dividing this weight gain of about 0.1 pounds by the approximately 270 days of the pregnancy period yields an increase in caloric intake due to fast-food by about 1.3 calories per day. (This calculation uses the CDC estimate that 3,500 additional calories induce a 1-pound weight increase). Even the larger estimate of weight gain for fast-food proximity at .1 mile still corresponds to only 4 calories per day. These estimates are one to two orders of magnitude smaller than the estimates for the children. This large difference is consistent with much higher transport costs for the 9th graders (who cannot drive) relative to mothers. In turn, the transport costs for the students induce a substantial monopoly power for the local fast-foods. Finally, we note that it is the large size of the data set that provides us with the precision needed to identify even effects of such small size.

(c) Additional Specifications. Table 8 shows estimates from a number of additional specifications. This Table generally follows the structure of Table 4.

Columns 1 to 3 present estimate models in which only one measure of restaurant availability is included in each regression. It is easier to see the declining effect of distance in these models than in Table 7. Column 1 indicates that conditioning on mother fixed effects, the probability of weight gain > 20Kg increases by 0.57 percentage points when there is a fast food restaurant within .1 of the mother's residence. Relative to the baseline probability (reported in Table 1) this amounts to a 4.4 percent effect. Importantly, there is no significant effect of proximity to a non fast food restaurant.

Consistent with Table 7, the effect of fast food restaurants declines with distance. Column 2 indicates that the effect is only 0.26 percentage points, or 2 percent, for restaurant openings that are within .25 miles of the mother residence. The effect for openings within .50 miles is 0.24 percentage points (column 3).

The remaining columns focus on the specification in column 3 which examines the impact of restaurant availability at .5 miles in models with mother fixed effects. The results for availability at closer distances (available upon request) are similar, with larger point estimates and larger standard errors. Column 4 asks whether there is an additional effect of having more than one fast food restaurant within .5 miles. We do not find any additional impact. Similarly, column 5 indicates that controlling for the number of non-fast food restaurants within .50 miles does not change the estimates.

Column 6 investigates the robustness of our estimates to a broader definition of fast food. The model includes the indicator for one of the top 10 fast food restaurants within .5 miles, an indicator for the presence of another fast food restaurant within .5 miles, and an indicator for the presence of a non fast food restaurant in this radius. As in Table 6, the broader definition does not have any additional impact over and above the baseline "top 10" definition, suggesting that there is something unique about the largest and most widely known fast food brands. Column 7 shows estimates from a model which excludes Subway from the top 10, since Subway is arguably healthier than the other chains. Excluding Subway raises the estimated coefficient on fast food slightly.

Column 8 reports estimates of a model where the independent variable is an indicator equal to 1 for any restaurant. Similar to our findings for schools and consistent with Anderson and Matsa (2009), we find no evidence that the presence of any restaurant affects weight gain during pregnancy.

Column 9 reports results from an optimal trimming model, where we include only schools that have a propensity score between .1 and .9. As explained above, this specification drops observations that are unlikely to be good controls. Finally, column 10 uses only the sample of mothers who live within 1 mile of a fast food restaurant. The results of these specifications are very consistent with the benchmark results in Column 3.[22]

Appendix Table A3 shows the effects of fast food on some additional birth outcomes. The results suggest that the availability of a top 10 fast food restaurant within .5 miles of the mother's residence is associated with a slightly higher incidence of diabetes, and with a lower probability of having gained a "normal" amount of weight (here defined as weight gain less than 16 kg). There is no effect on the probability that the mother had a very low weight gain (less than 16 pounds) or on the probability of low birth weight.

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[22] We did not estimate the optimal matching model on this sample, as the algorithm is not well suited to very large data sets.

(d) Placebo Analysis. In Table 9 we test whether there is evidence of changes in obesity rates as a function of *future* fast food restaurant openings. Column 1 reports estimates for models where the dependent variable is weight gain over 20Kg, while column 2 reports estimates from a model of continuous weight gain. While *current* fast food restaurants within 0.50 miles increase the current probability of weight gain above 20Kg, there is no evidence that *future* fast food restaurants increase weight gain. This is consistent with our identifying assumption.[23] Columns 3 and 4 show estimates from models that include indicators for whether there was a fast food restaurant in the mother's current location 3 years ago. This test is not as strong as the other because it is possible that lagged fast food exposure could have an effect on current weight gain. Here both current fast food and lagged fast food have positive coefficients in the regression for weight gain over 20Kg, but neither coefficient is statistically significant. In the model for continuous weight gain (column 4), only current fast food, not lagged fast food is significant.[24]

(e) Race and Education Differences. Finally, in Table 10 we investigate whether the obesity effect varies by race, ethnicity, and maternal education. For convenience, column 1 reproduces our preferred estimate from column 3 of Table 8.

Columns 2 to 4 report estimates for specific racial and ethnic groups from models that condition on mother fixed effects. A comparison of the estimated coefficients indicates that the effect of a new fast food restaurant is largest for African American mothers followed by Hispanic mothers, with no effect for non-Hispanic white mothers. In particular, the coefficient for African American mothers, .0065, is almost three times the coefficient for the average mother. Relative to the average of the dependent variable for blacks this amounts to a 5 percent increase in the probability of weight gain over 20 kilos.

We also consider differences on the basis of education. In columns 5 and 6 we separate mothers into those with high school or less (column 5) and those with higher

[23] Of course, these regressions are not quite analogous to those for schools because mothers can move. A difference in fast-food exposure over the years can occur because a fast-food restaurant opens or closes because a mother moves to an area with different fast-food exposure. This difference does not affect the placebo specification.

[24] We obtained very similar results if we examined 1 year or 2 year leads and lags.

education (column 6). We find that the impact is much larger in the less educated group, and that indeed, there is no effect on more educated mothers. The effect of non fast food restaurants is reliably zero across the different racial and educational categories

5. Conclusions

Obesity has increased rapidly in the U.S. since the 1970s. At the same time, the number of fast food restaurants more than doubled over the same time period. Exposes such as "Fast Food Nation" (Schlosser, 2001) and "Supersize Me" (Spurlock, 2004) highlight the popular perception that these two trends may be related—the availability of fast food may have caused at least some of the increase in obesity. Obesity has been linked to hypertension, cardiovascular disease, diabetes, and certain cancers so that the rise in obesity has become a serious public concern.

Yet, most of the existing evidence on the causal link between the supply of fast food and incidence of obesity is difficult to interpret because it is based on correlations. The concern is that fast food restaurants open in areas where the demand for fast food is strong. Since consumers have access to unhealthy food from many sources, it is possible that obesity rates would be higher in these areas even in the absence of fast food restaurants.

This paper investigates the health consequences of proximity to fast food for two vulnerable groups: young teens and pregnant women. The focus on very close distances and the presence of a large array of controls alleviates issues of endogenous fast-food placement. Our results point to a significant effect of proximity to fast food restaurant on the risk of obesity. Specifically, we show that the presence of a fast food restaurant within a tenth of a mile of a school is associated with at least a 5.2 percent increase in the obesity rate in that school (relative to the presence at .25 miles). Consistent with highly non-linear transportation costs, we do not find evidence of an effect at .25 miles and at .5 miles. The effect for pregnant women is quantitatively smaller and more linear in distance. We find that a fast food restaurant within a tenth of a mile of a residence results in a 4.4 percent increase in the probability of gaining over 20 kilos. This effect is reduced to a 2.5 percent increase when a fast-food is within a .5 miles from the residence of the mother.

These findings add new evidence to the debate on the impact of fast-food on obesity. First, we believe we have uncovered credible evidence that the availability of fast food has an effect on the obesity rate of teens and on weight gain in pregnant women. Second, we show that the effects of proximity are quite different for students (who are constrained to stay close to schools during the school day) than for mothers, who presumably are more mobile. Third, these findings have policy implications: Attempts to limit the presence of fast-food in residential areas are unlikely to have a sizeable impact, while narrower policies aimed at limiting access to fast food near schools could have a sizable impact on affected children.

Still, this research leaves several questions unanswered. The overall quantitative contribution of the expansion of the fast-food industry to the increase in obesity rate remains unclear. Relatively few schools are located within .1 miles of a fast food restaurant, so the impact identified by our paper applies to a relatively small population. And, while large numbers of pregnant women live within half a mile of a fast food restaurant, the majority does not. We cannot speculate about the generalizability of our research to other samples. It is possible that adolescents and pregnant women are uniquely vulnerable to the temptations of fast food. In addition, our research cannot distinguish between a rational price-based explanation of the findings and a behavioral self-control-based explanation. Finally, since fast food is ubiquitous in America, we cannot study the impact of fast-food entry in a society where fast food is scarce. We hope that these questions will be the focus of future research.

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Appendix 1: Definition of Fast Food Restaurant

There is little consensus about the definition of fast food in the literature. For example, the American Heritage Dictionary defines fast food as "Inexpensive food, such as hamburgers and fried chicken, prepared and served quickly." While everyone agrees that prominent chains such as McDonald's serve fast food, there is less agreement about whether smaller, independent restaurants are also "fast food."

The Census of Retail trade defines a fast food establishment as one that does not offer table service. Legislation recently passed in Los Angeles imposing a moratorium on new fast food restaurants in south central L.A. defined fast food establishments as those that have a limited menu, items prepared in advance or heated quickly, no table service, and disposable wrappings or containers (Abdollah, 2007). However, these definitions do not get at one aspect of concern about fast food restaurants, which is their heavy reliance on advertising, and easy brand recognition.

We constructed several different measures of fast food. Our benchmark definition of fast-food restaurants focuses on the top 10 chains, which are McDonald's, Subway, Burger King, Pizza Hut, Jack in the Box, Kentucky Fried Chicken, Taco Bell, Domino's Pizza, Wendy's, and Little Ceasar's. We have also constructed a broader definition using Wikipedia's list of national fast food chains (en.wikipedia.org/wiki/Fast_food). Wikipedia considers fast food to be "Food cooked in bulk and in advance and kept warm, or reheated to order." Our broadest definition starts with this list, excludes ice cream, donut, and coffee shops, and adds in all independent restaurants from our Dun and Bradstreet list that have the words "pizza" or "burger" in their names. The definition of "other restaurant" depends on the definition of fast food.

As discussed in the paper, we find a larger impact of the top 10 fast-food chains than for the broader definition of fast-foods. To conserve space, we show estimates for the broad definition excluding ice cream, donuts, and coffee shops, and for the top 10 chains.

Figure 1. Incidence of low birth weight and Low Apgar Scores

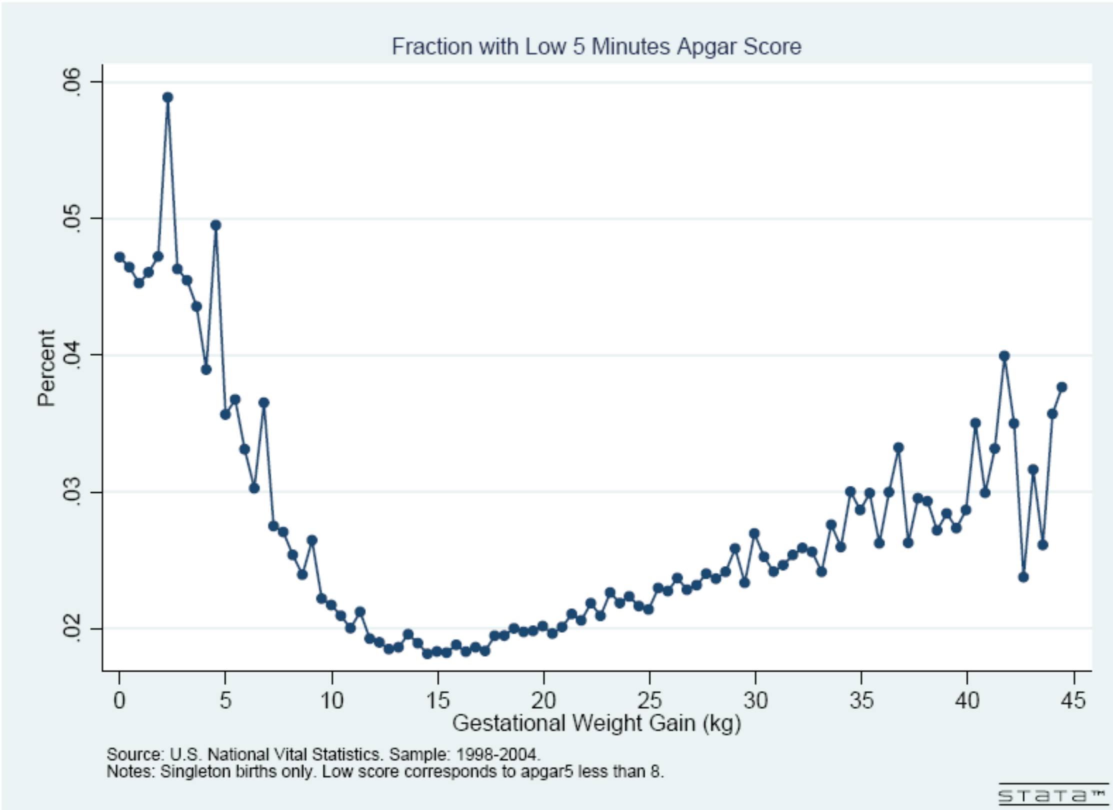

TABLE 1A
SUMMARY STATISTICS FOR SCHOOL DATA

	CA All	CA <.5 miles FF	CA <.25 miles FF	CA <.1 miles FF
# School-Year Observations	8373	5188	2321	559
No. Students per grade	366.27	384.30	383.05	400.74
School Characteristics				
Share Black students	0.084	0.093	0.093	0.086
Share Asian students	0.107	0.117	0.118	0.116
Share Hispanic students	0.380	0.409	0.416	0.436
Share immigrant students	0.034	0.029	0.030	0.033
Share eligible for free lunch	0.290	0.306	0.313	0.311
Average Test Scores 9th grade	56.255	54.964	54.737	52.291
Census Demographics of nearest block				
Median earnings	25674	24668	24271	23942
Share High-School degree	0.220	0.219	0.219	0.220
Share unemployed	0.083	0.085	0.088	0.079
Share Urban	0.912	0.974	0.971	0.987
Outcomes				
Percent obese students	32.949	33.772	33.724	35.733

TABLE 1B
SUMMARY STATISTICS FOR BIRTH DATA

	All Births	Siblings Only	Siblings <=.5 mi	Siblings <=.25 mi	Siblings <=.1 mi
# Mother-Year Observations	6732916	3531160	979792	303901	52953
Demographic Characteristics					
Mean age of mother	26.892	26.639	26.325	26.133	25.834
% age 15-24	0.289	0.298	0.319	0.333	0.356
% age 25-34	0.495	0.504	0.489	0.478	0.462
% 35+	0.118	0.099	0.090	0.085	0.078
% high school	0.314	0.306	0.306	0.309	0.308
% some college	0.317	0.321	0.289	0.275	0.254
% college or more	0.075	0.074	0.062	0.056	0.047
% black	0.160	0.170	0.199	0.198	0.203
% hispanic	0.299	0.281	0.331	0.348	0.372
% smoking	0.112	0.111	0.110	0.111	0.112
% child is male	0.512	0.512	0.511	0.511	0.508
Parity	0.914	1.060	1.087	1.083	1.076
% married	0.682	0.689	0.645	0.633	0.616
Outcomes					
% weight gain greater than 20kg	0.126	0.118	0.120	0.121	0.123
Mean weight gain	13.664	13.491	13.410	13.412	13.400

Notes: There are 1,527,328 mothers with greater than or equal to two children in the sample. In this sample there are 3,262 zip codes. 412,829 mothers experience a change in fast food availability within .5 miles, 181,250 experience such a change within .25 miles, and 37,976 experience a change within .1 miles.

TABLE 2A

PREDICTORS OF OBESITY AND FAST-FOOD PRESENCE NEAR SCHOOLS: CROSS-SECTION AND PANEL

Dep. Var.:	% Obese 9th graders		Availability of fast-food within distance from school					
			.5 miles	.25 miles	.1 miles	.5 miles	.25 miles	.1 miles
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. All Controls								
Share African American students	13.8132	3.852	0.3224	0.0395	-0.0422	-0.3886	0.009	-0.0877
in school	(2.7498)***	(10.8709)	(0.2217)	(0.1934)	(0.0715)	(0.2539)	(0.1636)	(0.0895)
Share Asian students	-3.5712	-28.3859	-0.0071	0.1433	-0.0407	0.2402	0.3009	0.0026
in school	(2.4789)	(8.8319)***	(0.1712)	(0.1495)	(0.0755)	(0.2313)	(0.1552)*	(0.0567)
Share Hispanic students	7.176	19.9484	-0.0582	0.155	0.0381	-0.1575	-0.0102	-0.0369
in school	(1.9494)***	(6.8332)***	(0.1432)	(0.1190)	(0.0524)	(0.2026)	(0.1146)	(0.0555)
Share of closest Census block	1.0413	-	0.1005	-0.0189	0.0431	-	-	-
that is urban	(0.9509)		(0.0475)**	(0.0360)	(0.0185)**			
Test Scores in 9th grade	-0.1953	-0.0441	0.0014	0.0013	-0.0004	-0.0016	-0.0002	-0.0001
	(0.0182)***	(0.0190)**	(0.0010)	(0.0009)	(0.0004)	(0.0005)***	(0.0003)	(0.0001)
Availability of Other Restaurants			0.4206	0.3218	0.1684	0.0116	0.0057	0.0328
within same distance			(0.0319)***	(0.0276)***	(0.0383)***	(0.0276)	(0.0196)	(0.0247)
F-Test Demographic Controls = 0	F=52.20***	F=4.72***	F=4.43***	F=1.16	F=0.99	F=1.55**	F=0.76	F=0.94
R^2	0.4284	0.6503	0.2836	0.228	0.133	0.926	0.9385	0.9287
Panel B. Single Predictor of Obesity								
Predicted Share of Obese 9th			0.0051	-0.0009	0.0008	-0.0048	-0.0015	-0.0004
Graders (Based on Controls)			(0.0021)**	(0.0017)	(0.0007)	(0.0026)*	(0.0024)	(0.0009)
Availability of Other Restaurants			0.5431	0.3485	0.1681	0.0124	0.0047	0.0332
within same distance			(0.0243)***	(0.0265)***	(0.0377)***	(0.0280)	(0.0195)	(0.0245)
R^2	0.4284	0.6503	0.2836	0.228	0.133	0.926	0.9385	0.9287
Specification:	Cross-Sect. Regression	School f.e. Panel	Cross-Sectional Regression			School Fixed-Effect Panel Regression		
Average of Dep. Var.	32.9494	32.9494	0.4696	0.1775	0.0397	0.4696	0.1775	0.0397
N	8373	8373	8373	8373	8373	8373	8373	8373

Panel C. Test of Uniform Distribution of Fast-Foods

No. fast foods at .25 miles - (No. fast foods at .1 miles * (2.5)^2) = -.0135 (s.e. .0552), n.s.
No. fast foods at .5 miles - (No. fast foods at .1 miles * 5^2) = -.1335 (s.e. .2245), n.s.

Notes: Each column is a different OLS regression. The regressions are weighted by the number of students. The dependent variable in Columns 1 and 2 is the percentage of students in the 9th grade who are classified as obese. The dependent variables in columns 3-8 are indicator variables for the presence of at least one fast-food restaurant within the prescribed distance from the school. The unit of observation is a school-grade-year for schools in California in the years 1999 and 2001-2007. The school-level controls are from the Common-Core data, with the addition of Star test scores for the 9th grade. The Census block controls are from the closest block to the address of the school. Standard errors clustered by school in parenthesis.

* significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent

TABLE 2B
PREDICTORS OF FAST-FOOD PRESENCE NEAR MATERNAL RESIDENCE: PANEL

Dep. Var.:	Weight Gain Larger than 20kg		Availability of fast-food within distance from mother's residence					
			.5 miles	.25 miles	.1 miles	.5 miles	.25 miles	.1 miles
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. All Controls								
African American mother	-0.0065	.	0.0013	-0.0004	0.0022	.	.	.
	(0.0013)***		(0.0059)	(0.0025)	(0.0008)***			
Hispanic mother	-0.0292	.	0.0101	0.0034	0.0019	.	.	.
	(0.0010)***		(0.0033)***	(0.0019)*	(0.0007)***			
Mother smokes	0.0137	-0.0048	0.0028	0.0006	0.0001	0.0035	0.0013	0.0003
	(0.0009)***	(0.0013)***	(0.0013)**	(0.0007)	(0.0003)	(0.0011)***	(0.0008)*	(0.0003)
Mother is married	-0.0132	-0.00545	-0.0036	-0.0017	-0.0007	0.0023	0.0010	0.0001
	(0.0007)***	(0.0009)***	(0.0013)***	(0.0007)**	(0.0003)***	(0.0010)**	(0.0007)	(0.0003)
Availability other restaurants within			0.263	0.154	0.0812	0.281	0.153	0.0792
same distance			(0.0049)***	(0.0033)***	(0.0031)***	(0.0008)***	(0.0006)***	(0.0006)***
F-Test Controls=0	F=372.1***	F=82.01***	F=2928.96***	F=18547.05***	F=20.26***	F=29.53***	F=7.426***	F=2.957***
R^2	0.008	0.006	0.072	0.068	0.043	0.073	0.063	0.039
Panel B. Single Predictor of Weight Gain								
Predicted probability of weight gain			0.169***	0.0754***	0.0242***	-0.455***	-0.118***	-0.0096**
> 20 kg (probit, based on controls)			(0.0203)	(0.0107)	(0.0038)	(0.0142)	(0.0094)	(0.0043)
Availability other restaurants within			0.272***	0.157***	0.0817***	0.282***	0.153***	0.0792***
same distance			(0.0048)	(0.0034)	(0.0031)	(0.0008)	(0.0006)	(0.0006)
R2			0.066	0.066	0.042	0.069	0.062	0.039
Specification:	Zip-Code f.e.	Mother f.e.	Zip-Code Fixed Effects Panel Regression			Mother Fixed Effects Panel Regression		
N	3019194	3019194	3531087	3531087	3531087	3531154	3531154	3531154

Notes: Each column is a different OLS regression. The unit of observation is a pregnancy for mothers with at least two births in the sample. The dependent variable in Column 1 and 2 is the indicator for pregnancy weight gain larger than 20kg. The dependent variables in columns 3-8 are indicator variables for the presence of at least one fast-food restaurant within the prescribed distance from the residence of the mother. All the regressions in Panel A include a full set of demographic controls listed in the text. Standard errors clustered by zip code (columns 1 and 3-5) or by mother (columns 2 and 6-8) in parenthesis.

* significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent

TABLE 3
IMPACT OF FAST-FOOD ON OBESITY IN SCHOOLS: BENCHMARK RESULTS

Dep. Var.:	Percent of 9th graders that are obese		
	(1)	(2)	(3)
Availability of Fast Food Rest.	3.0807	1.7385	6.3337
Within .1 miles	(1.6072)*	(0.8740)**	(2.5986)**
Availability of Other Restaurant	0.6817	-0.6162	1.0026
Within .1 miles	(1.0308)	(0.5704)	(1.6483)
Availability of Fast Food Rest.	-2.4859	-0.891	-1.7947
Within .25 miles	(1.1112)**	(0.5452)	(1.0932)
Availability of Other Restaurant	2.1416	0.0505	0.0375
Within .25 miles	(0.8757)**	(0.4895)	(0.8521)
Availability of Fast Food Rest.	1.3903	-0.0391	-0.8311
Within .5 miles	(0.8219)*	(0.4475)	(0.9826)
Availability of Other Restaurant	1.2266	0.4638	-0.4151
Within .5 miles	(0.8407)	(0.4881)	(0.7376)
Specification:	Cross-Sect. Regression No Controls	Cross-Sect. Regression Controls	School f.e. Panel Controls
R^2	0.0209	0.4296	0.6512
N	8373	8373	8373

Notes: Each column is a different OLS regression. The regressions are weighted by the number of students. The dependent variable is the percentage of students in the 9th grade who are classified as obese. The mean of the dependent variable is 32.9494. The unit of observation is a school-grade-year for schools in California in the years 1999 and 2001-2007. Entries in rows 1, 3 and 5 are the coefficient on a dummy for the existence of a fast food restaurant at a given distance from the school. Entries in rows 2, 4 and 6 are coefficient on dummy for the existence of a non-fast food restaurant at a given distance from the school. The school-level controls are from the Common Core of Data, with the addition of Star test scores for the 9th grade. The Census block controls are from the closest block to the address of the school. Standard errors clustered by school in parenthesis.

* significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent

TABLE 4
IMPACT OF FAST-FOOD ON OBESITY IN SCHOOLS: ROBUSTNESS

Dep. Var.:	Percent of 9th graders that are obese									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Availability of Fast Food Rest. Within .1 miles	1.1025 (0.8059)	4.618 (2.7405)*	1.668 (0.9080)*	2.0754 (0.9415)**	3.015 (1.6378)*			2.0234 (1.2898)	1.7916 (.9361)*	2.0046 (0.9658)**
Availability of Other Rest. Within .1 miles	-0.6725 (0.5226)	0.9707 (1.6460)	-0.6205 (0.5702)			-0.6134 (0.5648)		1.7044 (2.0437)		-1.0868 (0.8638)
Avail. of >=2 Fast Food Rest. Within .1 miles			0.415 (2.0676)							
No. of Other Rest. Within .1 miles				-0.4091 (0.2196)*						
Availability of Fast Food (Broad Def.) Restaurant Within .1 miles					0.0887 (1.7305)					
Availability of Non-Fast Food Rest. Within .1 miles					0.3447 (1.0437)					
Availability of Fast Food Rest. (Exclud. Subway) Within .1 miles						1.7223 (0.9071)*				
Availability of Any Restaurant Within .1 miles							-0.4719 (0.5393)			
Specification:	Cross-Section OLS	Panel OLS	Cross-Section OLS	Cross-Section OLS	Cross-Section OLS	Cross-Section OLS	Cross-Section OLS	Optimal Trimming	Matching Estimator	Proximity Regression
Includes Controls for Restaurants at .25 and .5 miles	No	No	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Sample:	All Schools	All Schools	All Schools	All Schools	All Schools	All Schools	All Schools	Schools with Prop. Score >=.1 and <=.9	All Schools	Schools with Fast Food Within .25 m.
R^2	0.4289	0.6507	0.4296	0.4309	0.0219	0.4295	0.4287	0.5116	.	0.4519
N	8373	8373	8373	8373	8373	8373	8373	992	8373	1486

Notes: Each column is a different OLS regression. The regressions are weighted by the number of students. The dependent variable is the percentage of students in the 9th grade who are classified as obese. The mean of the dependent variable is 32.9494. The unit of observation is a school-grade-year for schools in California in the years 1999 and 2001-2007. Entries in row 1 and 2 are the coefficient on a dummy for the existence of a fast fast food restaurant and a non-fast food restaurant closer than .1 miles from the school. The entry in row 3 is the coefficient on a dummy for whether there are 2+ fast food restaurants less than .1 miles from the school. The entry in row 4 is the coefficient on the number of non-fast food restaurants within .1 from the school. The entry in row 5 is the coefficient on a dummy for whether there is a fast food restaurant according to a broader definition (and not included in the benchmark definition) less than .1 miles from the school. The broad definition includes all restaurants classified as fast-foods by Wikipedia.

The school-level controls are from the Common Core of Data, with the addition of Star test scores for the 9th grade. The Census block controls are from the closest block to the address of the school. Standard errors clustered by school in parenthesis.

* significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent

TABLE 5
IMPACT OF FAST-FOOD ON OBESITY IN SCHOOLS: PLACEBOS

	Placebos based on lead		Placebo based on lag
Dep. Var.:	% of obese 9th graders		% of obese 9th graders
	(1)	(2)	(3)
Availability of Fast Food Rest. Within .1 miles	5.9191	-	1.0343
	(2.3877)**	-	(1.3777)
Availability of Other Restaurant Within .1 miles	0.414	0.2828	1.1174
	(1.6475)	(1.7644)	(1.0583)
Availability of Fast Food Rest. Within .1 miles 3 Years Later	-4.0011	-1.1628	
	(2.1361)*	(1.9063)	
Availability of Other Restaurant Within .1 miles 3 Years Later	-0.5785	-0.6153	
	(1.6646)	(1.7710)	
Availability of Fast Food Rest. Within .1 miles 3 Years Earlier			0.7887
			(1.3720)
Availability of Other Restaurant Within .1 miles 3 Years Earlier			-2.0254
			(1.0353)*
Sample:	All Schools	Schools with no Fast-Food at .1 miles	All Schools
Includes Controls for Restaurants at .25 and .5 miles	Yes	Yes	Yes
R^2	0.3877	0.3869	0.4302
N	4734	4551	8373

Notes: The regressions are weighted by the number of students. The dependent variable is the percentage of students in the relevant grade who are classified as obese. The unit of observation is a school-grade-year for schools in California in the years 1999 and 2001-2005. The sample in column 2 includes only schools that do not have a fast food restaurant located within .1 mile. Entries in row 1 (respectively, row 2) are the coefficient on a dummy for the existence of a fast food restaurant (respectively, non-fast-food restaurant) less than .1 miles from the school. The entry in row 3 (respectively, row 4) is the coefficient on a dummy for the existence of a fast food restaurant (respectively, non-fast-food restaurant) less than .1 miles from the school 3 years after obesity is measured. The entry in row 5 (respectively, row 6) is the coefficient on a dummy for the existence of a fast food restaurant (respectively, non-fast-food restaurant) less than .1 miles from the school 3 years before obesity is measured. The school-level controls are from the Common Core of Data. The Census block controls are from the closest block to the address of the school. Standard errors clustered by school in parenthesis.

* significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent

TABLE 6

HETEROGENEITY IN IMPACT OF FAST-FOOD ON OBESITY IN SCHOOLS

	% of obese 9th graders in demographic group				
Dep. Var.:	Whites	Hispanics	African American	Males	Females
	(1)	(2)	(3)	(4)	(5)
Panel A. Cross-Sectional Regression					
Availability of Fast Food Rest.	2.8149	2.0067	-1.5417	1.3833	1.9248
Within .1 miles	(1.0163)***	(1.0135)**	(1.2056)	(0.8002)*	(1.0002)*
Availability of Other Rest.	-0.8204	-0.3049	-0.4451	-0.5993	-0.6006
Within .1 miles	(0.7328)	(0.6169)	(0.8610)	(0.5425)	(0.6526)
R^2	0.284	0.2215	0.2516	0.401	0.4246
Panel B. Fixed-Effect Regression					
Availability of Fast Food Rest.	3.7168	5.4225	3.2754	3.9964	8.554
Within .1 miles	(2.5520)	(1.7801)***	(4.4318)	(2.3144)*	(2.6775)***
Availability of Other Rest.	0.7213	1.599	-4.0106	0.2259	1.5046
Within .1 miles	(1.4140)	(1.9890)	(2.2747)*	(1.7925)	(1.6370)
R^2	0.5482	0.5027	0.5716	0.6209	0.6469
Average of Dep. Var.	28.2286	36.9517	35.4517	33.7454	30.7471
N	6513	6946	2851	7780	7502

Notes: Each column is a different regression. The unit of observation is a school-grade-race-(or gender-)year in the years 1999 and 2001-2007.. The sample varies across racial groups (across genders) because race-specific (gender-specific) obesity is reported only for races (genders) that have at least 10 students in a given grade-school-year. Panel A presents the results of a cross-sectional regression which includes the full set of school-level and Census-block controls employed in Tables II and III, including controls for the availability of fast-food restaurants and other restaurants within .25 and .5 miles. Panel B presents the results of a fixed-effect regression which includes, in addition to the controls listed in Panel A, school fixed effects. Standard errors clustered by school in parenthesis.

* significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent

TABLE 7
IMPACT OF FAST-FOOD ON WEIGHT GAIN FOR MOTHERS: BENCHMARK RESULTS

Dep. Var.:	Weight Gain During Pregnancy Larger than 20kg		Weight Gain During Pregnancy in kilograms	
	(1)	(2)	(3)	(4)
Availability of Fast Food Rest.	0.0007	0.0033	0.0005	0.0734
Within .1 miles	(0.0018)	(0.0025)	(0.0337)	(0.0432)*
Availability of Other Restaurant	-0.0004	-0.0012	-0.0381	-0.0048
Within .1 miles	(0.0007)	(0.0010)	(0.0139)***	(0.0169)
Availability of Fast Food Rest.	0.0014	0.0007	0.0203	0.025
Within .25 miles	(0.0008)	(0.0013)	(0.0179)	(0.0215)
Availability of Other Restaurant	0.0002	0.0009	-0.0209	0.0185
Within .25 miles	(0.0005)	(0.0008)	(0.0103)**	(0.0129)
Availability of Fast Food Rest.	0.0011	0.0019	0.0168	0.0491
Within .5 miles	(0.0006)*	(0.0007)**	(0.0124)	(0.0135)***
Availability of Other Restaurant	0	-0.0001	-0.0364	-0.0165
Within .5 miles	(0.0006)	(0.0008)	(0.0113)***	(0.0136)
Specification:	Zip-Code Fixed Effects Panel	Mother Fixed Effects Panel	Zip-Code Fixed Effects Panel	Mother Fixed Effects Panel
R^2	0.008	0.006	0.018	0.023
N	3019194	3019256	3019194	3019256

Notes: Each column is a different OLS regression. The unit of observation is a pregnancy for mothers with at least two births in the sample. Entries in rows 1, 3 and 5 are the coefficient on a dummy for the existence of a fast food restaurant at a given distance from the mother's residence. Entries in rows 2, 4 and 6 are coefficient on dummy for the existence of a non-fast food restaurant at a given distance from the mother's residence. All the regressions include a full set of demographic controls listed in the text. Standard errors clustered by zip code (columns 1 and 3) or by mother (columns 2 and 4) in parenthesis.
* significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent

TABLE 8
IMPACT OF FAST-FOOD ON WEIGHT GAIN LARGER THAN 20KG: ROBUSTNESS WITH MOTHER FIXED EFFECT MODELS

Dep. Var.:	Weight Gain During Pregnancy Larger Than 20kg									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Distance x is:	.1 miles	.25 miles	.5 miles	.5 miles	.5 miles	.5 miles	.5 miles	.5 miles	.5 miles	.5 miles
Availability of Fast Food Rest.	0.0057	0.0026	0.0024	0.0029	0.0026	0.0019			0.0019	0.0019
Within x miles	(0.0024)**	(0.0011)**	(0.0007)***	(0.0008)***	(0.0007)***	(0.0009)*			(0.0008)**	(0.0009)**
Availability of Other Rest.	-0.0005	0.0008	0.0002	0.0002			0.0002		-0.0323	0.0003
Within x miles	(0.0009)	(0.0007)	(0.0008)	(0.0008)			(0.0008)		(0.0067)***	(0.0015)
Avail. of >=2 Fast Food Rest.				-0.0012						
Within .5 miles				(0.0011)						
No. of Other Rest.					0.0017					
Within .5 miles (100s)					(0.0040)					
Availability of Fast Food (Broad Def.)						0.0009				
Restaurant Within .5 miles						(0.0009)				
Availability of Non-Fast Food Rest.						-0.0002				
Within .5 miles						(0.0008)				
Availability of Fast Food Rest.							0.0025			
Within .5 miles excluding Subway							(0.0007)***			
Availability of Any Restaurant								0.0011		
Within .5 miles								(0.0007)		
Specification:	Mother Fixed Effects	Mother Fixed Effects	Mother Fixed Effects	Mother Fixed Effects	Mother Fixed Effects	Mother Fixed Effects	Mother Fixed Effects	Mother Fixed Effects	Optimal Trimming	Proximity Regression
Sample:	All Births	All Births	All Births	All Births	All Births	All Births	All Births	All Births	Births with Prop. Score >=.1 and <=.9	Mothers with Fast Food Within 1 mile
R^2	0.006	0.006	0.006	0.006	0.006	0.006	0.007	0.007	0.005	0.005
N	3019256	3019256	3019256	3019256	3019256	3019256	3019256	3019256	2189305	1842733

Notes: Each column is a different OLS regression. The unit of observation is a pregnancy for mothers with at least two births in the sample. Entries in row 1 and 2 are the coefficient on a dummy for the existence of a fast fast food restaurant and a non-fast food restaurant closer than the prescribed distance from the mother's residence. The entry in row 3 is the coefficient on a dummy for whether there are 2+ fast food restaurants less than .5 miles from the mother's residence. The entry in row 4 is the coefficient on the number of non-fast food restaurants within .5 miles from the mother's residence. The entry in row 5 is the coefficient on a dummy for whether there is a fast food restaurant according to a broader definition (and not included in the benchmark definition) less than .5 miles from the mother's residence. All the regressions include a full set of demographic controls listed in the text. Standard errors clustered by mother in parenthesis.

* significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent

TABLE 9
IMPACT OF FAST-FOOD ON WEIGHT GAIN: PLACEBOS

	Placebos based on leads		Placebos based on lags	
Dep. Var.:	WG>20kg	WG	WG>20kg	WG
	(1)	(2)	(3)	(4)
Availability of Fast Food Rest.	0.0035	0.0700	0.0010	0.0411
Within .5 miles	(0.0011)***	(0.0131)***	(0.0012)	(0.0215)*
Availability of Other Restaurant	-0.0006	-0.256	-0.0021	0.0284
Within .5 miles	(0.0011)	(0.0185)	(0.0012)*	(0.0189)
Availability of Fast Food Rest.	-0.0014	-0.0104		
Within .5 miles 3 Years Later	(0.0011)	(0.0186)		
Availability of Other Restaurant	0.0012	0.0245		
Within .5 miles 3 Years Later	(0.0012)	(0.0131)		
Availability of Fast Food Rest.			0.0019	0.0291
Within .5 miles 3 Years Earlier			(0.0013)	(0.0208)
Availability of Other Restaurant			0.0025	-0.0239
Within .5 miles 3 Years Earlier			(0.0012)**	(0.0199)
Specification:	Mother Fixed Effects	Mother Fixed Effects	Mother Fixed Effects	Mother Fixed Effects
R^2	0.007	0.024	0.008	0.026
N	3019256	3019256	2694834	2694834

Notes: Each column is a different OLS regression. The unit of observation is a pregnancy for mothers with at least two births in the sample. Entries in rows 1 and 2 are coefficients on a dummy for the existence of a fast food restaurant and a non-fast food restaurant respectively within 0.5 miles from the mother's residence. Entries in rows 3 and 4 are coefficients on a dummy for the existence of a fast food restaurant and a non-fast food restaurant respectively within 0.5 miles from the mother's residence three years after the pregnancy. Entries in rows 5 and 6 are coefficients on a dummy for the existence of a fast food restaurant and a non-fast food restaurant respectively within 0.5 miles from the mother's residence three years before the pregnancy. All the regressions include a full set of demographic controls listed in the text. Standard errors clustered by mother in parenthesis.

* significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent

TABLE 10
HETEROGENEITY IN IMPACT OF FAST-FOOD ON WEIGHT GAIN LARGER THAN 20KG

	Weight Gain During Pregnancy Larger than 20kg					
Dep. Var.:	All	White	African American	Hispanic	High School or Less	Some College or
	(1)	(2)	(3)	(4)	(5)	(6)
Availability of Fast Food Rest.	0.0023	-0.0011	0.0066	0.0022	0.0033	0.0002
Within .5 miles	(0.0007)***	(0.0011)	(0.0016)***	(0.0013)*	(0.0009)***	(0.0012)
Availability of Other Rest.	0.0001	0.001	-0.0032	-0.0015	0.0000	0.0004
Within .5 miles	(0.0008)	(0.0010)	(0.0021)	(0.0015)	(0.0010)	(0.0011)
Specification:	Mother Fixed Effects	Mother Fixed Effects	Mother Fixed Effects	Mother Fixed Effects	Mother Fixed Effects	Mother Fixed Effects
Average of Dep. Var.	0.126	0.122	0.131	0.101	0.126	0.106
R^2	0.006	0.01	0.002	0.011	0.007	0.007
N	3019262	1720325	495045	794535	1779895	1236989

Notes: Each column is a different OLS regression. The unit of observation is a pregnancy for mothers with at least two births in the sample. Entries in row 1 are coefficients on a dummy for the existence of a fast food restaurant at within 0.5 miles from the mother's residence. Entries in row 2 are coefficients on a dummy for the existence of a non-fast food restaurant within 0.5 miles from the mother's residence. All the regressions include a full set of demographic controls listed in the text. Standard errors clustered by mother in parenthesis.

* significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent

APPENDIX TABLE 1
FAST-FOOD RESTAURANTS AND OTHER RESTAURANTS

Top-10 Fast-Food Restaurants		Major Fast-Food Restaurants in Wikipedia List and not in top-10		Major Restaurants in non-Fast Food Category	
Rank	Name	Rank	Name	Rank	Name
(1)	(2)	(3)	(4)	(5)	(6)
1	Mc Donalds	1	Starbucks	1	Ihop
2	Subway	2	Dairy Queen	2	Sizzler
3	Burger King	3	Baskin Robbins	3	Togos Eatery
4	Taco Bell	4	Jamba Juice	4	Chilis
5	Pizza Hut	5	Fosters Freeze	5	Applebees
6	Little Caesars	6	Orange Julius	6	Tcby
7	Kfc	7	Smoothie King	7	Cocos
8	Wendys	8	Juice Stop	8	Aramark
9	Dominos Pizza	9	Braums	9	El Café
10	Jack In The Box	10	Moes Southwest Grill	10	Pomodoro

Notes: Data on restaurant establishments are from Dun & Bradstreet. See discussion in Appendix 1 for more details on our classification of restaurants.

APPENDIX TABLE 2
IMPACT OF FAST-FOOD ON OBESITY IN SCHOOLS: ALL FITNESS MEASURES

Dep. Var.:	Percent of 9th graders not fit in test					
Test:	Obesity (Low Fat Content)	Abdominal Strength	Aerobic Capacity	Flexibility	Trunk Strength	Upper Body
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Cross-Sectional Regression						
Availability of Fast Food Rest.	1.7385	-0.2462	-1.4257	-2.9971	1.102	-2.951
Within .1 miles	(0.8740)**	(1.5579)	(1.8154)	(1.4496)**	(1.3752)	(1.7414)*
Availability of Other Rest.	-0.6162	1.0758	-1.1739	0.8341	-0.7435	-0.5001
Within .1 miles	(0.5704)	(0.8870)	(1.1195)	(0.8794)	(0.8451)	(1.1778)
R^2	0.4296	0.3618	0.4946	0.217	0.2117	0.2786
Panel B. Fixed-Effect Regression						
Availability of Fast Food Rest.	6.3337	2.8514	0.822	0.1704	6.0512	1.9535
Within .1 miles	(2.5986)**	(2.1178)	(2.3191)	(2.9216)	(3.2289)*	(3.3450)
Availability of Other Rest.	1.0026	0.5629	-0.2362	0.4003	3.0409	-0.382
Within .1 miles	(1.6483)	(1.7773)	(1.6372)	(2.2357)	(1.9444)	(1.9984)
R^2	0.6512	0.6863	0.8	0.5466	0.5467	0.6623
Average of Dep. Var.	32.9591	21.2723	51.0022	31.4660	17.3974	34.9211
N	8373	8260	8172	8227	8028	8363

Notes: Each column is a different OLS regression with a different measure of lack of fitness as dependent variable. The regressions are weighted by the number of students. The unit of observation is a school-grade-year for schools in California in the years 1999 and 2001-2007. Panel A presents the results of a cross-sectional regression which includes the full set of school-level and Census-block controls employed in Tables II and III, including controls for the availability of fast-food restaurants and other restaurants within .25 and .5 miles. Panel B presents the results of a fixed-effect regression which includes, in addition to the controls listed in Panel A, school fixed effects. Standard errors clustered by school in parenthesis.

* significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent

APPENDIX TABLE 3
IMPACT OF FAST-FOOD ON VARIOUS HEALTH OUTCOMES FOR PREGNANT MOTHERS

Dep. Var.:	Diabetes	Hypertension	Weight gain < 16kg	Weight gain < 16 pounds	Low birth weight
	(1)	(2)	(3)	(4)	(5)
Panel A. Zip-Code Fixed Effects					
Availability of Fast Food Rest.	0.000799	0.000113	-0.00257	0.000862	0.000404
Within .1 miles	(0.000240)***	(0.000110)	(0.000841)***	(0.000613)	(0.000333)
Availability of Other Rest.	0.000427	0.000438	0.00217	0.00467	0.00166
Within .1 miles	(0.000244)*	(0.000118)***	(0.000765)***	(0.000571)***	(0.000350)***
N	3503350	3503350	3019194	3019194	3522400
R^2	0.008	0.003	0.011	0.017	0.012
Panel B. Mother Fixed Effects					
Availability of Fast Food Rest.	0.000510	0.000150	-0.00532	-0.000856	-0.0000279
Within .1 miles	(0.000286)*	(0.000149)	(0.000953)***	(0.000737)	(0.000471)
Availability of Other Rest.	-0.000711	0.000456	0.00153	0.00226	0.00156
Within .1 miles	(0.000305)**	(0.000158)***	(0.00103)	(0.000745)***	(0.000473)***
N	3503417	3503417	3019256	3019256	3522467
R^2	0.005	0.002	0.012	0.014	0.002

Note: Each column is a different OLS regression. The unit of observation is a pregnancy for mothers with at least two births in the sample. Entries in row 1 are coefficients on a dummy for the existence of a fast food restaurant at within 0.5 miles from the mother's residence. Entries in row 2 are coefficients on a dummy for the existence of a non-fast food restaurant within 0.5 miles from the mother's residence. All the regressions include a full set of demographic controls listed in the text. The regressions in Panel A also include zip-code fixed effects, while the regressions in Panel B include mother fixed effects. Standard errors clustered by zip or mother in parenthesis.
* significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent