Healthy school meals and Educational Outcomes

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This paper provides field evidence on the effects of diet on educational outcomes, exploiting a campaign lead in the UK in 2004, which introduced drastic changes in the meals offered in the schools of one Borough – Greenwich - shifting from low-budget processed meals towards healthier options. We evaluate the effect of the campaign on educational outcomes in primary schools using a difference in differences approach; comparing educational outcomes in primary schools (key stage 2 outcomes more specifically) before and after the reform, using the neighbouring Local Education Authorities as a control group. We find evidence that educational outcomes did improve significantly in English and Science. We also find that the campaign lead to a 15% fall in authorised absences – which are most likely linked to illness and health.

Keywords: Child nutrition, Child health, School meals, Education, Natural Experiment, Placebo effect

JEL-codes: J13, I18, I28, H51, H52

"Mens Sana in Corpore Sano"

(A Sound Mind in a Sound Body)

Juvenal (Satire 10.356)

1. Introduction

Children's diet has deteriorated tremendously over the last decades, and has become a major source of preoccupation in developed countries, in particular in view of the rising rates of obesity among young children, observed across almost all developed countries.[1] According to the World Health Organization (2002), nutrition is related to five of the ten leading risks as causes of disease burden measured in DALYs (Disability Adjusted Life Years) in developed countries i.e. high blood pressure, cholesterol, overweight (obesity) and iron deficiency. Importantly, children's poor diet does not only have direct negative effects on their weight and health, but also results in significant deficiencies in those nutrients playing an essential role in cognitive development (see Lambert et al. (2004)). A number of studies point at the significant and *immediate* effect of diet on behaviour, concentration and cognitive ability; as well as on the immune system, and therefore the ability to attend school (see Sorhaindo and Feinstein (2006) for a review).

A number of studies provide quasi-experimental evidence of a causal relationship between diet and obesity (Whitmore (2005), Anderson and Butcher (2006a, 2006b)), and in particular between the availability of junk food at school on children's obesity. Little is known though on the effect of poor diet on other outcomes, and in particular, on learning and cognitive ability. There are a number of studies documenting correlations between *malnutrition* and educational outcomes (see Pollitt (1990), Behrman (1996), Alderman et al. (2001), Glewwe et al. (2001)), but most of this literature concentrates on developing countries (and therefore on malnourishment rather than poor eating habits), and few of them are able to establish a *causal* effect, i.e. they do not have a source of exogenous variation in nutritional habits.

[1] For example, in the UK, 15% of children aged 2 to 10 were classified as "obese" in 2006, compared to 10% only 10 years ago (Health Survey for England)

This paper exploits a unique "natural experiment" in the UK – the "Feed Me Better" campaign lead in 2004-2005 by the British Chef Jamie Oliver aimed at improving the nutritional standards at school. Because the campaign was literally designed and implemented as a large-scale experiment, it offers a unique opportunity to assess the causal effects of diet on educational outcomes. Drastic changes to school menus were introduced in the 80 schools of one borough – Greenwich – the idea being that these schools would then serve as examples for the rest of the country.

School meals are of major importance in British schools, with about 45% of school kids in primary and secondary schools eating school lunches every day[2], and are therefore an obvious instrument for policy intervention in children's diet. In addition, school meals are part of a means-tested programme; children from less privileged backgrounds receive school meals for free. In 2006, around 18% of the entire pupil population was eligible for the free school meal programme.[3] Hence, school meals provide a direct way for policy-makers to possibly reduce disparities in diet between children from more and less privileged socio-economic backgrounds, which in turn could contribute to reduce differences in educational outcomes. School meals seem also to be more important now than in the past, because children rely more on food provided at school now than three decades ago. For example, Anderson, Butcher and Levine (2003) show that increases in maternal employment rates in the US have been associated with an increase in obesity rates, which they attribute partly to the decrease in the consumption of home cooked meals.

Using pupil and school-level data from the National Pupil Database (NPD) and from the School census covering the period 2002-2007, we evaluate the effect of the campaign on educational outcomes and on absenteeism in primary schools using a difference in differences (DD) approach; comparing educational outcomes (key stage 2 outcomes more specifically) before and after the reform, using the neighbouring Local Education Authorities as a control group. We find that the campaign improved educational achievements. Our estimates show that the campaign increased the percentage of pupils reaching level 4 by 4.5 percentage points in English, and the

2 Source: School Food Trust.
3 See appendix for details of eligibility criteria

percentage of pupils reaching level 5 by 6 percentage points in Science. However, the estimates are not very precise, such that we cannot exclude small positive effects. Nevertheless, it is noteworthy to find *any* significant effect, because the campaign was not directly targeted at improving educational outcomes and, also, we are looking at improvements within a relatively short horizon (2 years). One could have expected that changing diet habits is a long and difficult process, which would possibly only have effects after a long time, effects that would be hard to measure. Next to these educational outcomes, we find clear evidence that *authorised* absences (which are more likely to be linked to sickness) drop by 15% on average in Greenwich relatively to other LEAs. Interestingly, we find no such effect on *unauthorised* absences (less likely to be linked to sickness).

The paper is structured as follows. Section 2 discusses the existing evidence in the literature on the relationship between nutrition and educational outcomes. Section 3 describes the background of the "Feed me Better Campaign". Section 4 presents the data and descriptive statistics and Section 5 presents the results of the empirical analysis. Section 5 concludes.

2. Related literature

Despite the importance of the subject in the public and policy arenas, there are only a limited number of studies on the causal effect of children's diet on health on the one hand, and educational outcomes on the other.

The medical literature has carried out a number of studies on the relationship between diet and behaviour, concentration and educational outcomes. Sorhaindo and Feinstein (2006) provide a review of this literature. They mention four different channels through which nutrition may affect educational outcomes. The first channel is through physical development. A poor diet leaves children susceptible to illness and in turn, greater illness results in more days of absence and thereby a decrease in teacher contact hours. The second channel is through cognition and the ability to concentrate. Numerous studies have found a link between diet and the ability of children to think and concentrate. In particular deficiencies in iron can have an impact on the development of the central nervous system and also cognition in later life. Sorhaindo and Feinstein (2006) point out that the effects of diet on children's school performance are relatively immediate. The third channel mentioned in their review is behaviour. For example, there is a causal link between a deficiency in vitamin B and behavioural problems; particularly related to aggressive behaviour. McCann et al. (2007) find that artificial colouring and additives resulted in increased hyperactivity in 3-year-old and 8/9 year old children in the general population. Some studies even establish a link between diet and anti-social, violent and criminal behaviour (see Benton (2007) for a review), in particular the omega-3 fatty acid DHA decreased hostility and aggression. Behavioural problems could also spill-over on other pupils in the classroom through peer effects. The research in this area is more limited. Finally, the last channel mentioned is through school life and in particular difficult school inclusion due to obesity. Overall, the conclusion one can draw from the medical literature (see also Bellisle (2004)) is that a well balanced diet is the best way to enable good cognitive and behavioural performance at all times.

Economists have recently devoted more attention to the determinants and effects of obesity, and child obesity in particular. Anderson and Butcher (2006a) review the literature investigating the possible reasons underlying the rise in child obesity. They conclude that there does not seem to be one single determining factor of the rise, rather a combination of factors. Interestingly, they do point at the important changes in the school environment, such as the availability of vending machines in schools, as a possible factor triggering calories intake and thereby obesity. One study they have carried out (Anderson and Butcher (2006b)) link school financial pressures to the availability of junk food in middle and high schools, and estimate that a 10 percentage point increase in the provision of junk food at school produces an average increase in BMI of 1 percent, while for adolescents with an overweight parent the effect is double. Effects of this size can explain about a quarter of the increase in average BMI of adolescents over the 1990's. Whitmore (2005) evaluates the effects of eating school lunches (from the US based National School Lunch Program) on childhood obesity. She uses two sources of variations to identify the effect of eating school lunches on children's obesity. First, she exploits within-individual time variation in school lunch participation, and second, she exploits the discontinuity in eligibility for reduced-price lunch – available to children from families earning less than 185 percent of the poverty rate – and compares children just above and just below the eligibility cut-off. She finds that students who eat school lunches are more likely to be obese. She attributes this effect to the poor nutritional content of lunches and concludes that healthier school meals could reduce child obesity.

There are a limited number of studies studying the effect of diet on educational performance, based on interventions in the US. Kleinman et al. (2002) and Murphy et al. (1998) study the effects of an intervention providing free school breakfasts and found evidence of a positive effect on school performance. However, the evidence is limited to small-scale interventions.

A recent study by Figlio and Winicki (2005) find that schools tend to change the nutritional content of their lunches on test days. They present this as evidence of strategic behaviour of schools, which seem to exploit the relationship between food and performance as a way of gaming the accountability system. Using disaggregate data from schools in the state of Virginia, they find that those schools who are most at risk of receiving a sanction for not meeting proficiency goals, increase the number of calories of school lunches on test days. This strategy seems to be somewhat effective, with significant improvements in test scores for examinations that took place after lunch (mathematics and English). However, they argue that these changes are targeted at immediate and short-lived improvements in performance, based on an increase of the number of calories and glucose intake, rather than a long-term strategy aimed at providing a healthier and balanced diet to children.

3. Background: School Meals and the "Feed Me Better" Campaign

School meals in England[4]

School meals were introduced at the beginning of the 20th Century in England, following a rising concern about severe malnutrition of children attending school.

[4] Nelson et al. (2004) and Nelson et. (2006) provide an extensive report on school meals in primary and secondary schools in England, based on a survey across a representative sample of schools and pupils.

After the Second World War, the policy shifted from providing food to malnourished children to providing meals for all children. Nutritional standards were established in 1941 covering energy, protein and fat. In 1980, a change in policy occurred, removing the obligation to meet any nutritional standards. Local Authorities had discretion on the price, type and quality of meals they provided. It was not until 2001 that compulsory minimum nutritional standards were reintroduced. These standards were relatively low though and hardly enforced. A survey conducted by Nelson et al. (2006) in the year 2005 (April to June) in England show that only 34 of the sampled 146 primary schools met all the compulsory nutritional standards. The two standards most commonly failed were "starchy food cooked in oil or fat to be available no more than three times a week" (failed by 53% of lunch services) and "fruit-based desserts to be available twice a week" (failed by 33%). The study finds that the most popular food choices among children were desserts, cakes, biscuits and ice cream (78% of pupils). Higher fat main dishes were chosen by nearly twice as many pupils (53%) as lower fat main dishes (29%), the same was true for chips and other potatoes (chosen by 48% of pupils) in comparison to potatoes not cooked in oil or fat (25%).

Overall, less than 50% of meals as chosen and as eaten met Caroline Walker Trust Nutritional guidelines for school Meals (guidelines for a balanced diet set by an expert working group) for essential nutrients such as Vitamin A, folate (B vitamin), calcium, iron, percent of energy from fat and from saturated fat.

The "Feed me Better" Campaign

The British Chef Oliver started the campaign "Feed me Better" in 2004, drawing attention to the poor quality of meals offered in schools. The campaign was publicised through a TV documentary broadcast in February 2005 on one of UK channels (Channel 4). The programme featured mainly one school in Greenwich (Kidbrooke secondary school), the first school where the changes were implemented. The idea of the campaign was to drastically change the school meal menus in all schools of the borough of Greenwich, as an "experiment" that would serve as an example for the rest of the country.

Typically, the Local Education Authorities are in charge of allocating a budget to schools. Schools have contractual agreements with catering companies – the largest one in the UK at the time was Scholarest. These contracts are long-term contracts and short-term changes to menus are very difficult to implement. Oliver obtained the agreement of the Council of Greenwich to change the menus (provided the menus would stay within budget). The large majority of schools in the Greenwich area switched from their old menus to the new menus in the school year of 2004-2005. Before the campaign, school meals were mainly based on low-budget processed food. In the Appendix, we provide an example of menus as they were before and after the Jamie Oliver campaign.

The campaign mobilised a lot of resources, involved retraining the cooks (most cooks participated to a three-day boot camp organised by the Chef) and equipping the schools with the appropriate equipment. Clearly, the implementation has not been straightforward and it would have been very difficult for schools in other LEAs to have made these changes on such a large scale in such a short amount of time.

In September 2004 at the start of the autumn term Jamie hosted an evening for all the head teachers in which they were invited to take part in the experiment. 81 of the 88 head teachers signed up. The aim was to roll the scheme, which completely replaced the junk food with healthy alternatives, out in 6 weeks, so it commenced just after the half term-October 2004. The scheme was rolled out gradually across the borough, five schools at a time. By February 2005, more than 25 schools had removed all processed foods and implemented the new menus.[5] The roll out had taken place fully by September 2005 with 81 of the 88 schools taking part in the scheme, with those unable to participate due to lack of kitchen facilities.

As part of the experiment the council increased the investment specifically into school meals: an initial increase in the school food budget by £628,850 was agreed in the February 2005 budget going to cover the cost of the extra staff hours that were needed for the preparation of the meals, equipment costs and promotion to the parents. By September 2007 a total £1.2 million had been invested in the experiment[6].

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[5] In the pilot school of Kidbrooke, the healthy meals were initially being put alongside the original junk food. In most cases children preferred to stick to the junk food rather than opting for the healthy meals. This was not the case when the scheme was rolled out across the borough.

[6] Source: www.greenwich.gov.uk

Despite the initial difficulties of implementation, the evaluation of the campaign has been quite positive. The website of the "Heath Education Trust"[7] for example mentions the following reactions: The Head teacher of Kidbrooke School said, "*Because the children aren't being stuffed with additives they're much less hyper in the afternoons now. It hasn't been an easy transition as getting older children to embrace change takes time*". One classroom teacher commented: "*Children enjoy the food and talk about it more than they did in the past. They seem to have more energy and can concentrate for longer*."

We have some information on the nutritional content of the meals offered to the children before the changes, although only through the TV programme. The Jamie Oliver team asked a nutritionist to analyse a sample of the pre-campaign meals. The meals were lacking fruit and vegetables, and the meat/fish was reconstituted, rather than fresh. Overall, the meals were lacking in basic nutrients, such as iron and vitamin C. Furthermore, the reform included removing all junk food.

4. Data, sample and descriptive statistics

4.1 Data and Sample

We investigate the effects of the campaign on three outcome variables: Educational outcomes, absenteeism and take-up rates. We limit our analysis to primary schools, for two main reasons: 1) The recent economic literature has pointed to the importance of interventions in early childhood[8], 2) primary school children are typically not allowed to leave the school during lunch time, while secondary children are. Therefore, primary school children are less likely to have been able to substitute for school meals by alternative food (such as buying junk food in neighbouring outlets). Since the number of junk outlets per secondary school is 36.7 on average in the Inner London area[9], it is more challenging to identify with certainty the treated group.

7 Source: http://www.healthedtrust.com/

8 Heckman et al. (2006) who stresses the importance of early interventions even before the children enter school.

9 Source: School Food Trust; Inner London includes: Hammersmith and Fulham, Kensington and Chelsea, Westminster, Camden, Islington, City, Hackney, Tower Hamlets, Soutwark, Lambeth, Wandsworth, Lewisham and Greenwich; the number is calculated by dividing the total number of outlets in the area by the number of secondary schools in that area.

We use detailed individual data from the National Pupil Database (NPD), which matches information collected through the Pupil Level Annual Schools Census (PLASC) to other data sources such as Key Stage attainment.

The NPD contains information on key pupil characteristics. These include several variables such as ethnicity, a low-income marker and information on Special Education Needs (SEN), that we have matched with Key Stage 2 attainment records. Key Stage 2 corresponds to the grades 3 to 6 in England; and all pupils take a standardized test at the end of the Key Stage (in year 6, typically at the age of 11). The Key Stage 2 test has three main components: English, Maths and Sciences. We will consider these three components separately.

Our empirical analysis follows closely Machin and McNally (2008). We conduct two levels of analysis. We have school level data, that is, data aggregated at the school level on the levels attained by pupils (levels 3, 4 and 5); where level 4 is the national standard target as set by the government. We also use individual pupil data. In this case we have individual test scores. Rather than using the raw scores, we create a percentile rank score (as in Machin and McNally (2008)). This prevents any mark scheme changes from driving the results.

Our second outcome measure is absenteeism at the school level, measured by the percentage of half days missed (the data has been extracted from the DCSF publication tables)[10]. We have two levels of absenteeism, authorised and unauthorised. Authorised absences are those where the pupil has received permission from the school to miss the time from school. This is typically, although not exclusively, because of illness. Unauthorised absences include absences that have not been permitted by the school; this would in most cases include no illness based absences. Hence although we do not have any direct measures of health, authorised absenteeism is our closest proxy.

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[10] Source: http://www.dcsf.gov.uk/performancetables/

Finally, we investigate the effect of the campaign on take-up rates of school meals, for children who are eligible for free school meals (provided by the DCSF). There is no public information available on the take-up rate for all children, so this measure is the closest indicator we have to assess the effect of the campaign on take-up.

We concentrate the analysis on the school years from 2002 to 2007, and exclude the year 2005, because changes in menus were introduced in the course of the year 2004-05. Note that we do not have information about the exact timing of these changes in each school and even if we would have this information, differences in timing are unlikely to be exogenous. Thus, we prefer to exclude the whole school year 04-05 from the analysis.

We use five neighbouring Local Education Countries as controls for the analysis. The campaign was implemented in one borough only, the idea being to use this as an experiment for the whole country. Of course, Greenwich has specific characteristics; it is in the neighbourhood of London and is a relatively poor area. There are potentially a large number of possible controls though and we chose to use as controls LEAs that resemble Greenwich most in terms of health indicators (obesity rates), socio-economic characteristics, such as the proportion of whites, proportion of households living in social housing and the unemployment rate. Figure 1 shows the geographical location of these LEAs and Table 1 presents summary neighbourhood statistics of these LEAs. Note that we will also conduct a robustness analysis where we will extend the control group to other LEAs in the London area (see Section 5.2 e)).

4.2 Descriptive statistics

Table 2 compares control and treatment schools on a number of observable characteristics, as well as educational outcomes, before and after the campaign. Although we have chosen the control LEAs for their similarities with Greenwich, there are a number of notable differences worth pointing out. The percentage of white pupils is higher in Greenwich than in the control areas. The reverse is true for the percentage of pupils speaking English as their first language (this specific difference will be alleviated in the robustness analysis with the extended control group). On the other hand, indicators of social deprivation, such as the Income Deprivation Affecting Children Index and the percentage of pupils eligible for free school meals are comparable in the treatment and control groups. Importantly for our analysis, these indicators are quite similar before and after the campaign.

Turning to educational outcomes, we find that most indicators do increase between 2004 and 2006, both in the treatment schools and in Greenwich. Looking at the raw means, we see a slight relative improvement in performance in Greenwich in comparison to other LEAs.

We now turn to a more detailed empirical analysis.

5. Analysis

5.1 Empirical strategy

As in Machin and McNally (2008), we estimate a difference-in-differences model on school level outcomes and individual outcomes. We estimate the following model at the school level:

$$Y_{slt} = \alpha + \beta \text{ Greenwich}_l + \gamma \text{ Greenwich}_l * \text{ Post-2005}_t + \varphi Z_{st} + \lambda Z_s + + \pi_t T_t + \rho_l t + \varepsilon_{ist}$$

Where Y_{slt} denotes the outcome variable for school *s* in LEA *l* in year *t*; Greenwich is a dummy variable equal to 1 for the LEA of Greenwich and 0 for the five neighbouring LEAs; Post-2005 is a dummy variable equal to 1 for school years 2004-05, 2005-06 and 2006-07 and 0 for school years 2002-03, 2003-04, *Z* is a vector of school characteristics; T is a set of yearly dummies; and ε_{ist} is an error term. In addition to the Machin and McNally (2008) specification, we also allow for LEA specific trends (captured by the parameters ρ_l).

γ is our main coefficient of interest. It shows how pupil performance changed in Greenwich schools in comparison to other LEAs. If the campaign had a positive effect on diet and performance, we should find a positive coefficient.

Secondly, we estimate the following model with individual data:

$$Y_{islt} = \alpha + \beta \, Greenwich_l + \gamma \, Greenwich_l{*} \, Post\text{-}2005_t + X_{ist}'\delta + \lambda Z_{st} + \pi_t \, T_t + \rho_l t + \varepsilon_{ist}$$

Where Y_{islt} denotes the outcome variable for pupil *i* in school *s* and LEA *l* ; and *X* is a vector of pupil characteristics. Again, γ is our main coefficient of interest.

5.2 Results

a) Effect on educational outcomes

We first study the effect of the campaign on school-level outcomes, more precisely, on the percentage of pupils reaching (1) level 3 or more, (2) level 4 or more or (3) level 5 in English, maths and science respectively.

We start with the analysis based on school-level data. The results for the different specifications are presented in Table 3. We find that Key stage 2 results are significantly improved, specifically in English and Science. We find a significant effect of the interaction dummy on the percentage of pupils reaching level 4 in English and on the percentage of people reaching level 5 in Science. The effects are quite large: We find that the percentage of pupils reaching level 4 or more in English increased by 4.5 percentage points and the percentage of pupils reaching level 5 for science increased by 6 percentage points. We should point out that the coefficients are close to zero for the percentage of pupils reaching level 3 and above, and positive for levels 4 and 5. However, the standard errors are quite large, and we cannot rule out small (or even negative) effects, as we can also not rule out relatively large effects.

The bottom of Table 3 reports the results of DD estimates based on pupil level data. We find that the results significantly improved in English. Again, the coefficients are positive for test scores in Maths and Science as well, but the standard errors are large and we cannot reject that they have not been affected. Note that the dependent variable here is the test score result, thus the picture suggests that even though we cannot reject that the Science test scores did not change on average, it seems that they have improved at the top of the distribution, which enabled some pupils to reach level 5 instead of level 4.

Overall the results so far show some evidence that educational outcomes improved in the Greenwich area relatively to other neighbouring LEAs. The estimated coefficients are relatively high, but so are the standard errors. Thus, a careful conclusion is to note that there is some evidence pointing in the direction of a positive effect. This is quite noteworthy though, given that these effects are within a relatively short horizon and given that the campaign was not directly targeted at improving educational outcomes.

It is important to note that only part of the pupils included in the analysis has truly been treated: those who actually eat school meals and experienced a change in diet because of the campaign. Unfortunately, we do not have individual information about who is eating school meals and who is not – thus our estimates measure the effects of the "intention-to-treat" and are likely to be a lower bound. As we mentioned earlier, 45% of the children eat school meals at school. We now investigate whether we can identify subgroups of the pupil population that have been more affected than others.

Heterogeneous effects

First, we investigate whether we find any differences in effects across the free school meal (FSM) eligibility status[11]. We know from Table 2 that about 36% of children in Greenwich and 40% in the control LEAs are eligible for free school meals. Note that *eligibility* does not mean *take-up* or actual *consumption* of the meal. We have information on the take-up rates for eligible children and we will investigate the effects of the campaign on these take-up rates in the next section, but we do not have information on the take-up rates (or actual consumption) of those who are not eligible for free school meals. Thus, we *do not know* whether FSM children are more or less likely to have been "treated" by the campaign.

Table 4 presents DD estimates when we split the sample according to the free school meal status. We find that most of the positive significant effects decrease or disappear entirely for the FSM children. Thus, we fail to find evidence that the campaign specifically helped those children who benefit from free school meals. One possible

11 Free school meals eligibility criteria: Parents do not have to pay for school lunches if they receive any of the following: Income support, income-based Jobseeker's Allowance, support under Part VI of the Immigration and Asylum Act 1999, Child Tax Credit, provided they are not entitled to working tax credit and have an Annual income (as assessed by HM Revenue & Customs) that does not exceed £15,575, the Guarantee element of State Pension Credit.

story is that FSM children and parents from these children may be harder to get on board and that children from richer socio-economic backgrounds might be more receptive to the changes in school meals. This is important to point out though, in the context of using this policy as a possible mechanism to reduce disparities across children.

We investigate further whether we find evidence of heterogeneous effects according to gender, race and "special educational needs" status (remaining of Table 4). Again, we have a priori no clear reasons to expect some groups to be more affected than others, because we do not know the distribution of school meal consumption across these groups. We find no clear evidence of heterogeneous effects. Girls seem to have been more affected, but we cannot reject that the effect of the reform was identical across gender. Thus, we cannot conclude that the reform affected some students more than others, except according to their free school meal status.

b) Effects on absenteeism

We now turn to the effects of campaign on absenteeism. We have information at the school level on the percentage of authorised and unauthorised absences. Authorised absences are those that are formally pre-authorised by the school, thus most likely linked with sickness. Table 5 shows the results of the DD analysis, both on the percentage of authorised an unauthorised absences. We find a substantial negative effect on authorised absences; the rate of absenteeism drops by about .80 percentage points, which corresponds to 15% of the average rate of absenteeism. On the other hand, we do not find a significant effect on unauthorised absences.

The relative fall in absenteeism could in itself drive part of the improvement in educational outcomes, although obviously only a small part of the population of pupils has presumably been affected by this fall. In Table 6, we compare the results we have presented earlier (in Tables 3, based on the school level data) with results controlling for authorised absenteeism at the school level. We find that the coefficients reported earlier remain very similar. Thus, the effects on educational achievements are not due to the change in absenteeism. However, it could be that for those children for whom absenteeism does change, the improvement in educational achievements is more substantial than for the others. Unfortunately, we are unable to identify those children in the pupil-level data.

c) Effect on take-up rates

We now examine the effect of the campaign on the take-up rates of free school meals. As we mentioned earlier, we do not have information on whether children did indeed consume the meals or not (the anecdotal information we have points that, indeed, children were far from enthusiastic at the beginning but did adjust relatively quickly to the new menus), nor do we have information on the overall take-up rates of school lunches. We do have, however, detailed information at the school level on the percentage of children taking up free school meals (conditional on eligibility).

Changes in take-up rates are important to look at because, obviously, falling take-up rates would jeopardise the success of the campaign. On the other hand, it could be that improvements in the quality of the food encourage take-up.

We report the results in Table 6. We find no evidence of a change in take-up rates. Obviously, this does not mean that there has been no change in the actual consumption of school meals. As we discussed earlier, the change in menus had not been implemented easily and some children were reluctant to accept the new menus. At least, these results show that there was no change in the recorded take-up rates.

d) Placebo effect

One concern is that the campaign affected educational outcomes not through the improvement in diet, but simply through a "placebo-effect". Indeed, the schools were very well aware they were part of a pilot experiment and the campaign received a lot of media attention. Thus, we should worry that the effect we measure is a placebo effect rather than an actual effect of the campaign.

We should note that any reform of this kind, that is, where one group of people is treated and another is not, is potentially subject to this placebo effect. In contrast to experiments in medicine for example, it is virtually impossible to think of a way of administering a placebo treatment to a control group. Any change in policy could affect outcomes simply because those who are treated know they are treated. There is usually no way researchers can be sure that the effect they estimate is truly due to the change in policy rather than a placebo effect.

In this particular case, it is not clear whether the effects we find could be driven by such a placebo effect. On the one hand, this campaign has received attention from the media, which possibly could trigger a placebo effect. On the other hand, the attention was very much focused on the health benefits, and in particular on tackling the problem of obesity, rather than improving school performance. Also, we are looking at outcomes *more than a year* after the campaign and have excluded the year of the campaign itself. It is hard to believe that school children would remain motivated by a placebo effect more than a year after the campaign has been implemented.

Our setting, nonetheless, gives us some scope to investigate the placebo effect to some extent. As the campaign was part of a programme broadcast on one of the major channels in the UK, we have good reasons to believe that some schools were probably more subject to a possible placebo effect than others. Some of the treated schools were explicitly mentioned in the program, such that one could expect that for those schools, the placebo-effect could be stronger than others. However, there were only 7 schools explicitly mentioned in the programme, so we should be careful in interpreting the results, as idiosyncratic changes in one of these schools will weigh more on the estimates.

We have extended the empirical analysis by adding an interaction term for those schools that were explicitly mentioned during the programme (note that some of them were just very briefly mentioned, there was no filming on location). We present the results in Table 7 for English, Maths and Science respectively. The evidence points in the direction of a "disruption effect" rather than a positive placebo effect. In the case of Maths, we find that the interaction coefficient is significant and negative, while we find no positive effect of the campaign overall. For English and Science, the interaction dummy is in most cases negative but is not significant. Additional evidence on this disruption is that there were many initial problems in the schools that took on the scheme early on. Further, as the programme was rolled out, a food week was introduced and tasting sessions for the parents were organised; hence those later schools would have had a slightly different treatment than the early schools.

Since there are only few of these schools, we do not wish to draw too much attention to these estimates, but we conclude that, at least, there is little evidence of a positive placebo effect.

e) Robustness checks

To make sure that the effects we have identified are not a statistical coincidence, we run a number of robustness checks. Appendix B presents the results of the robustness analysis on Key Stage 2 scores and Appendix C presents the results of the robustness analysis on absenteeism. First, we conducted a placebo analysis attributing the role of treated successively to each LEA included in the control group (Tables B1-B5 and C1). The results we find are much less consistent. More precisely it is only in Greenwich that we find systematically and consistently positive DD estimates for Key Stage 2 scores and negative DD estimates for absenteeism. We find no such pattern in any of the other LEAs. Second, we conducted a placebo analysis by attributing the year of treatment successively to 2002-2003 and 2003-2004 (Tables B6-B7 and C2). None of the coefficients are significant when the treatment year is attributed to a placebo year. Finally, we considered a wider group of control LEAs, including LEAs that are not as close to Greenwich as the ones we selected for the main analysis[12] (Tables B8 and C3). The results remain almost identical. Altogether, the robustness analysis provides strong evidence that the effects we have identified are not a statistical coincidence and the only convincing explanation for the effects seems to be the Jamie Oliver campaign.

f) Spill-over and selection effects

One legitimate concern regarding the analysis and the results is whether school meals did remain similar in the control LEAs after the campaign. As we mentioned earlier, the campaign was public and thus could have spilled over to the schools not directly

[12] Lambeth, Lewisham, Southwark, Tower Hamlets, Wandsworth, Bexley, Croydon, Kingston upon Thames, Merton, Newham, Richmond, Sutton; see Figure 1.

involved in the campaign. This seems very unlikely for two reasons: First, the campaign proved to be quite resource-intensive and not straightforward to implement, it involved the re-training of kitchen staff and the improvement of kitchen equipment. Other schools could not realistically have implemented similar changes at the same time. Second, schools are involved in long-term contracts with catering services and thus could not directly renegotiate menus and food provision. Nevertheless, it could be that the campaign raised public awareness and this may have affected parental behaviour, possibly even at home. We have no information that such changes have taken place but, in any case, this would imply that our results provide a lower bound on the effects of diet on educational achievements.

Another issue may be whether the new menus made Greenwich schools more attractive for parents to send their children to relative to the other LEAs. Mobility across LEAs could introduce a selection problem and bias our estimates, for example if those children who move towards healthier schools are relatively better pupils in terms of educational performance and presence at school. Unfortunately, we do not have data on the number of applications to primary schools, but one indication of possible selection effects is the mean IDACI score – the mean socio-economic index. Figure x shows the IDACI score remaining constant over the analysis period suggest that the composition of the households of Greenwich schools, and our treatment schools remained constant.

g) Costs and benefits

The last exercise that we propose is a back-of-the-envelope costs and benefits analysis. Note that since we do not detailed information about health outcomes, our estimates probably provide also a lower bound on the *overall* benefits of the program. As indicated by the relative fall in absenteeism, it is likely that children's health improved as well, which could also have long-lasting consequences for the children involved not only through improved educational achievements, but also in terms of their life expectancy, quality of life, and productive capacity on the labour market. We can only provide an estimate of the long-term benefits accrued through better learning and better educational achievements. The effects we have identified are comparable in magnitude to those estimates by Machin and McNally (2008) for the "Literacy Hour".

The "Literacy Hour" was a reform implemented in the nineties in the UK to raise standards of literacy in schools by improving the quality of teaching through more focused literacy instruction and effective classroom management. They found that the reform increased the proportion of pupils reaching level 4 or more in reading increased by 3.2 percentage points, an effect very similar to the effect we have estimated.

They calculated the overall benefit in terms of future labour market earnings using the British Cohort Study, that includes information on wages at age 30 and reading scores at age 10. They estimate the overall benefit of the reform to be between £75.40 and £196.32 (depending on the specification) per annum, and assuming a discount rate of 3% and a labour market participation of 45 years (between 20 and 65) implies an overall lifetime benefit between £2,103 and £5,476.

It is worthwhile discussing not only the benefits of the programs, but also the costs. As we have mentioned earlier, the campaign lead to substantial increases in costs in terms of retraining the cooking staff, refurbishing kitchens, and even the food costs have increased slightly as well. By September 2007, the council of Greenwich alone had invested £1.2 million in the campaign. About 28,000 school children in the county benefited from the healthy school meals, thus, the cost per pupil was around £43. The largest proportion of these costs was one-off costs (refurbishing kitchens, retraining staff), such that in the long-term, the long-term cost per pupil should be substantially lower. There is therefore no doubt that the campaign provides large benefits in comparison to its costs per pupil.

5. Conclusion

This paper exploits the unique features of the "Jamie Oliver Feed Me Better" campaign, lead in 2004 in the UK, to evaluate the impact of healthy school meals on educational outcomes. The campaign introduced drastic changes in the menus of meals served in schools of one borough – Greenwich – and banned junk food in those schools. Since the meals were introduced in one Local Education Area only at first, we can use a difference in differences approach to identify the *causal* effect of healthy meals on educational performance.

Using pupil and school level data, we evaluate the effect of the reform on educational performance in primary schools; more precisely we compare Key Stage 2 test scores results before and after the campaign, using neighbouring local education areas as a control group. We identify positive effects of the "Feed me Better Campaign" on Key Stage 2 test scores in English and Sciences. The effects are quite large: Our estimates show that the campaign increased the percentage of pupils reaching level 4 by 4.5 percentage points in English, and the percentage of pupils reaching level 5 by 6 percentage points in Science. We also find that authorised absences (which are likely to be linked to sickness) drop by 15% on average. These effects are particularly noteworthy since they only capture direct and relatively short-term effects of improvement in children's diet on educational achievements. One could have expected that changing diet habits is a long and difficult process, which would possibly only have effects after a long time, effects that would be hard to measure.

It is worth pointing out that the campaign did not particularly affect the "free school meal" children. Indeed, we do not find significant changes in the performance of those children, despite the fact that we find no significant changes in take-up rates. This is worth pointing at, in the light of using school meals as a way of reducing disparities in diet across children.

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TABLES AND FIGURES

Figure 1: Local education authorities in the London area

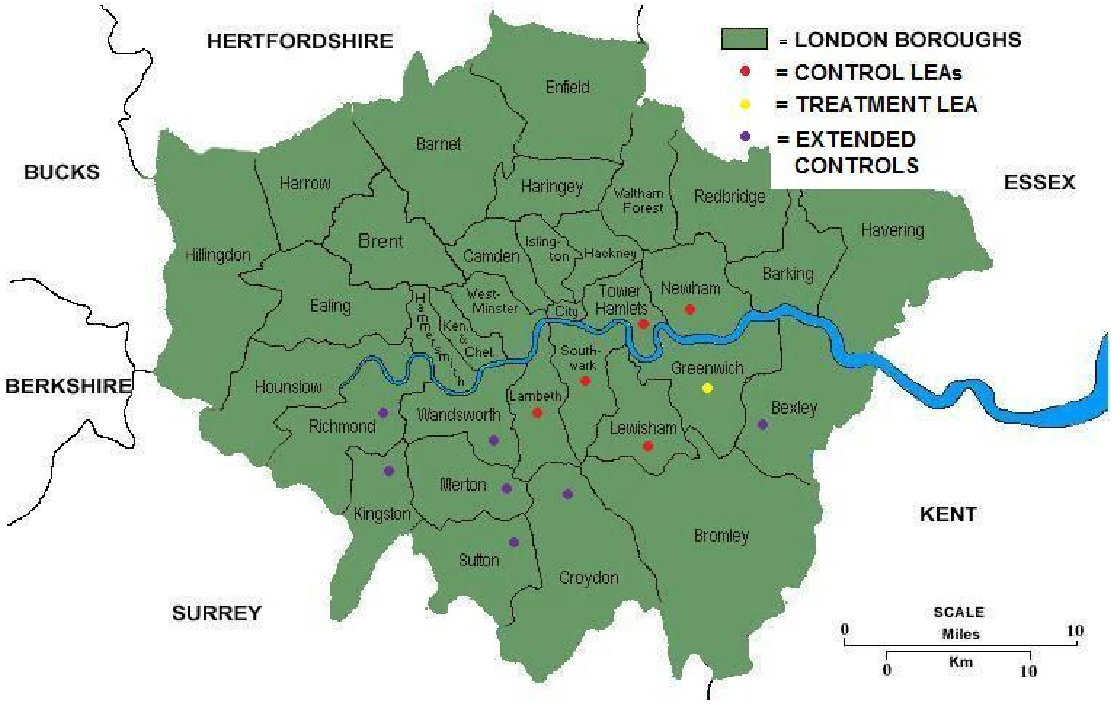

Figure 2: Average IDACI Scores

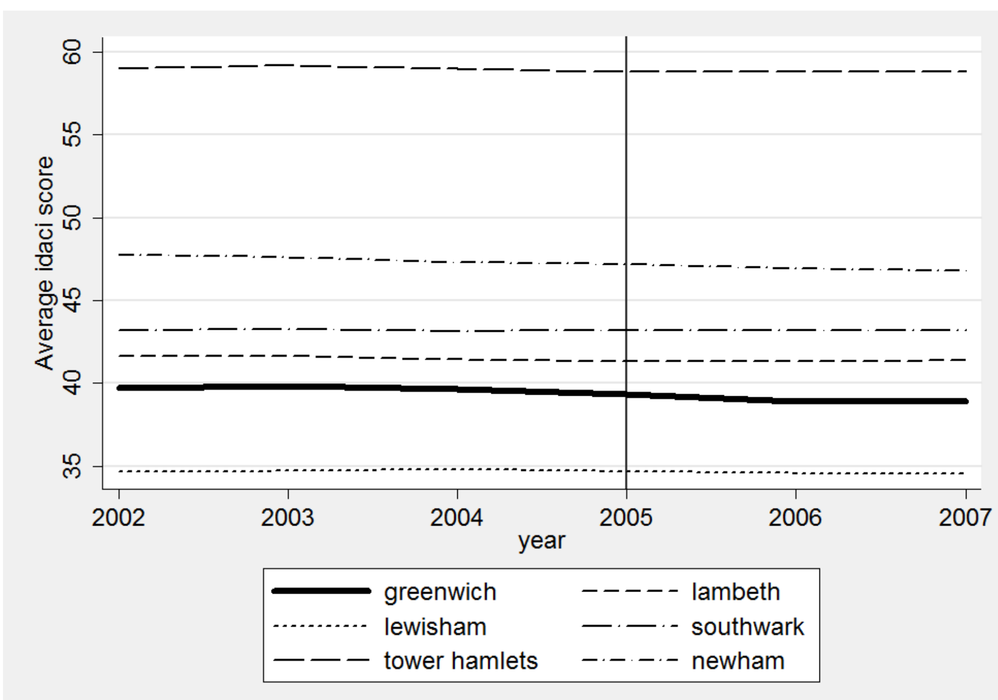

Table 1 - Neighbourhood statistics

	Greenwich	Lambeth	Southwark	Lewisham	Newham	Tower Hamlets
Proportion of whites	77.1%	62.4%	63.0%	65.9%	39.4%	51.4%
Long-term unemployment rate[1]	1.9%	2.0%	2.1%	1.9%	2.1%	2.2%
Social housing[2]	39.5%	41.4%	53.4%	35.6%	36.5%	52.5%
Rate of obesity[3]	20.2%	16.8%	19.7%	19.2%	21.2%	11.9%
Free School meals Eligility[4]	36.4%	39.0%	37.8%	29.2%	37.9%	55.0%
Price of a school meal[5]	£1.30	-	£1.15	£1.10	£1.25	£1.50

Source: Office for National Statistics (Neighbourhood statistics) [1] Obesity rates among adults (obesity is such that body mass index > 20), survey from 2003-2005, [3] People aged 16-74: Economically active: Unemployed (Persons, census April 2001), [4] Percentage of households living in housing rented to the Local area council (Census 2001), [4] Percentage of pupils eligible for free school meals (School Census 2004)

Table 2 - Control and treatment schools – Summary statistics
(Standard deviations in parentheses)

	Non-Greenwich		Greenwich	
	2004	2006	2004	2006
Average no. of pupils	341.43	302.6	308.4	278.74
	(156.75)	(134.51)	(115.65)	(107.33)
% of pupils eligible for Free School Meals	39.84	40.44	36.44	35.59
	(15.54)	(15.58)	(16.5)	(15.66)
% of pupils female	48.2	47.95	47.56	47.25
	(7.14)	(7.72)	(9.4)	(9.29)
% of pupils with some special need	25.42	27.92	27.88	30.93
	(20.13)	(19.81)	(20.02)	(20.02)
% of pupils with statement of special need	7.4	7.36	6.16	6.88
	(22.48)	(22.18)	(20.34)	(20.45)
% of pupils non-white	68.74	70.66	40.07	44.08
	(18.23)	(17.75)	(19.48)	(20.71)
& of pupils who have English as a first Language	51.11	49.42	75.21	70.42

	(26.56)	(26.46)	(16.74)	(18.31)
Average IDACI[13] score	45.15	45	39.67	38.94
	(10.65)	(10.67)	(10.49)	(9.92)
% Faith School	26.21	26.21	23.94	23.94
	(44.04)	(44.04)	(42.98)	(42.98)
English: Proportion attaining level 3 and above	87.11	89.43	86.93	89.71
	(18.09)	(17.58)	(18.13)	(15.12)
English: Proportion attaining level 4 and above	70.48	73.88	68.72	73.61
	(20.16)	(19.85)	(19.76)	(16.64)
English: Proportion attaining level 5 and above	21.71	26.16	20.88	26.51
	(14.94)	(16.41)	(15.1)	(14.24)
Maths: Proportion attaining level 3 and above	87.3	89.33	87.39	89.75
	(18.16)	(17.47)	(17.76)	(15.17)
Maths: Proportion attaining level 4 and above	68.53	71.06	68.3	72.13
	(19.16)	(19.2)	(17.83)	(17.83)
Maths: Proportion attaining level 5 and above	26.44	27.59	25.88	29.59
	(13.43)	(13.76)	(13.73)	(14.2)
Science: Proportion attaining level 3 and above	87.83	89.76	88.24	90.64
	(18.22)	(17.56)	(17.7)	(14.98)
Science: Proportion attaining level 4 and above	77.18	78.93	76.54	80
	(19.83)	(19.89)	(19.33)	(17.16)
Science: Proportion attaining level 5 and above	32.99	35.5	31.63	37.86
	(18.53)	(17.98)	(17.63)	(18.91)
Pupil Teacher Ratio	21.87	20.38	21.43	20.5
	(6.05)	(5.26)	(5.44)	(4.98)
Pupil Staff Ratio	10.83	9.81	12.29	11
	(3.03)	(2.68)	(3.34)	(2.92)
Authorised Absence (% half days missed)	4.79	5.06	5.42	5.31
	(1.13)	(1.13)	(1.08)	(1.15)
Unauthorised Absence (% half days missed)	1.05	1.08	1.24	1.27
	(1.04)	(0.92)	(1.13)	(0.96)

13 **Income Deprivation Affecting Children Index shows the percentage of children in each SOA (Super Output Area) that live in families that are income deprived(ie, in receipt of Income Support, Income based Jobseeker's Allowance, Working Families' Tax Credit or Disabled Person's Tax Credit below a given threshold), DCSF)**

Table 3 - Difference-in-difference estimates - Key stage 2 results

School level data

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
% Level 3 and above			
Greenwich*Post 2005	0.350	0.325	-0.197
	(1.659)	(1.725)	(1.580)
% Level 4 and above			
Greenwich*Post 2005	4.533*	2.467	3.000
	(2.541)	(2.926)	(2.852)
% Level 5 and above			
Greenwich*Post 2005	2.717	2.196	6.067*
	(3.288)	(2.826)	(3.666)
Number of observations	1991	1991	1991
Number of schools	415	415	415
Number of pupils	67,805	69,073	69,824
School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

Pupil level data – Percentile score

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
Greenwich*Post 2005	4.713**	1.697	3.582
	(2.271)	(2.235)	(2.578)
Number of schools	403	404	405
Number of pupils	78,665	79,761	80.801
Individual & School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

Note: Standard errors in parentheses (clustered by school). *** p<0.01, ** p<0.05, * p<0.1. Individual controls include: free school meal eligibility, gender, some special needs requirement, special needs statement, ethnicity, English as a first language, Income Deprivation Affecting Children Index score (idaci), month of birth dummies. School controls include: % with free school meal eligibility; % girls; % require special needs, with and with-out statement, % of different ethnicities , % English as a first language, average Income Deprivation Affecting Children Index (idaci), faith school indicator. All regressions contain specific LEA trends and year dummies. Control LEAs include: Southwark, Lewisham, Tower Hamlets, Newham and Lambeth.

Table 4 - Difference-in-differences estimates – Key stage 2 results Heterogeneous effects (pupil level data)

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
Free school meal status			
Greenwich*Post 2005*NFSM	6.688***	3.822*	5.788**
	(2.481)	(2.254)	(2.561)
Greenwich*Post 2005*FSM	1.239	-1.824	0.0812
	(3.212)	(3.102)	(3.323)
P Value of test of no difference	0.009	0.109	0.200
Gender			
Greenwich*Post 2005*Boys	3.371	0.319	1.829
	(2.881)	(2.595)	(3.047)
Greenwich*Post 2005*Girls	5.711**	2.751	5.142*
	(2.373)	(2.524)	(2.812)
P Value of test of no difference	0.421	0.622	0.321
Race			
Greenwich*Post 2005*white	3.308	3.639	5.399**
	(2.609)	(2.499)	(2.602)
Greenwich*Post 2005*non-white	5.634**	-0.762	1.741
	(2.803)	(3.024)	(3.704)
P Value of test of no difference	0.026	0.645	0.024
Special educational need			
Greenwich*Post 2005*no statement	4.898**	1.883	3.365
	(2.276)	(2.262)	(2.598)
Greenwich*Post 2005*statement	-9.855	-4.768	11.54
	(10.63)	(8.783)	(8.699)
P Value of test of no difference	0.990	0.957	0.570
Individual & School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

Table 5 - Difference-in-differences estimates – Absenteeism (school level data)

	Authorised Absenteeism	*Unauthorised Absenteeism*	*Total absenteeism*
Greenwich*Post 2005	-0.782***	-0.404	-1.201***
	(0.273)	(0.261)	(0.365)
Number of observations	1853	1777	1777
Number of schools	380	379	379
School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

See notes to table 3.

Table 6 – Difference-in-differences estimates – Key stage 2 results
With and without controls for absenteeism
(School level data)

	English		Maths		Science	
	No controls for absenteeism rate	Controlling for authorised absenteeism	No controls for absenteeism rate	Controlling for authorised absenteeism	No controls for absenteeism rate	Controlling for authorised absenteeism
% Level 3 and above	0.350	0.369	0.325	0.432	-0.197	-0.174
Greenwich*Post 2005	(1.659)	(1.693)	(1.725)	(1.640)	(1.580)	(1.524)
% Level 4 and above	4.533*	4.597*	2.467	3.247	3.000	4.135
Greenwich*Post 2005	(2.541)	(2.706)	(2.926)	(2.953)	(2.852)	(2.964)
% Level 5 and above	2.717	2.722	2.196	2.715	6.067*	6.881*
Greenwich*Post 2005	(3.288)	(3.566)	(2.826)	(3.062)	(3.666)	(3.950)
Number of observations	1991	1848	1991	1848	1991	1848
Number of Schools	415	380	415	380	415	380
School Controls	Yes	Yes	Yes	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

See notes to table 3.

Table 7: Difference-in-differences estimates – Take up rates and eligibility (school level data)

	(1)	(2)
	% FSM Take up rate	***% FSM Eligibility***
Greenwich*Post 2005	-0.379	-0.217
	(1.146)	(0.436)
Number of observations	2033	2039
Number of schools	421	421
School Controls	Yes	Yes
School Fixed Effects	Yes	Yes

See notes to table 3.

Table 8: Difference-in-differences estimates - Placebo effect (School level data)

	English Key Stage 2 results	Maths Key Stage 2 results	Science Key Stage 2 results
% Level 3 and above			
Greenwich*Post 2005	0.277	0.300	-0.205
	(1.686)	(1.752)	(1.607)
TV*Post 2005	0.733	0.250	0.0810
	(1.806)	(1.826)	(1.420)
% Level 4 and above			
Greenwich*Post 2005	4.636*	3.109	3.085
	(2.603)	(3.014)	(2.939)
TV*Post 2005	-1.038	-6.440*	-0.843
	(3.093)	(3.854)	(2.606)
% Level 5 and above			
Greenwich*Post 2005	2.651	3.293	6.615*
	(3.331)	(2.845)	(3.864)
TV*Post 2005	0.659	-11.00***	-5.502
	(2.135)	(3.841)	(5.772)
Observations	1991	1991	1991
Number of Schools	415	415	415
School Controls	Yes	Yes	Yes
School Fixed Effects	Yes	Yes	Yes

See notes to table 3.

APPENDIX: Sample of menus

Before the Jamie Oliver Campaign

Mains: burgers and chips; sausage rolls; fish fingers; turkey drummers; chicken dinosaurs

Desserts: sponge pudding and custard; milk shake and home made biscuit; fruit salad

Example of weekly menus introduced with the Jamie Oliver campaign

* = Meat Option ** = Fish Option V = Vegetarian Option

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
WEEK 1 Bread & Salad Bar Everyday	* Proper Sausages Creamy Mash Peas & Sweetcorn Mexican Bean Wrap (v) Cheesy Leek Pasta (v) Peas & Sweetcorn Salad Vanilla Sponge & Custard	* Chicken & Mushroom Casserole * Chilli Con Carne Savoury Rice & Salad Vegetable Chow Mein (v) Salad Fruit Crumble & Custard	* Roast Beef Roast Potatoes, Green Beans & Gravy Mushroom & Lentil Bake (v) Roast Potatoes & Green Beans ** Tuna Jacket Potato Green Beans Fresh Fruit Platter & Custard	* Lamb & Vegetable Pie Veggie Mince Pie (v) ** Creamy Coconut Fish New Potatoes Broccoli Creamed Rice Pudding	* BBQ Chicken Cheese Flan (v) Jacket Wedges Salad * Cottage Pie Seasonal Vegetable Fresh Fruit & Custard

source: www.greenwich.gov.uk

Appendix B - Robustness checks for results regarding Key Stage 2 tests

Table B1: Difference-in-difference estimates – Lambeth

	English Key Stage 2 results	Math Key Stage 2 results	Science Key Stage 2 results
Pupil level data – Percentile score	1.244	1.089	0.476
	(2.584)	(2.231)	(2.628)
School level data			
% Level 3 and above	-0.0124	-0.847	-0.250
	(2.092)	(2.310)	(2.243)
% Level 4 and above	-4.873	-0.645	0.339
	(3.415)	(3.297)	(3.004)
% Level 5 and above	6.379	7.340**	-0.387
	(4.299)	(2.838)	(3.639)

Note: Standard errors in parentheses (clustered by school). *** p<0.01, ** p<0.05, * p<0.1; all estimates include school controls and school fixed effects; and results on pupil level data include individual controls (see Table 3)

Table B2: Difference-in-difference estimates – Lewisham

	English Key Stage 2 results	Math Key Stage 2 results	Science Key Stage 2 results
Pupil level data – Percentile score	3.293	-0.648	2.567
	(2.866)	(2.718)	(3.088)
School level data			
% Level 3 and above	2.306	2.325	1.239
	(2.058)	(2.145)	(2.055)
% Level 4 and above	5.154*	-0.195	0.955
	(3.070)	(3.180)	(2.929)
% Level 5 and above	5.217	-0.218	7.597**
	(3.735)	(3.194)	(3.861)

Note: Standard errors in parentheses (clustered by school). *** p<0.01, ** p<0.05, * p<0.1; all estimates include school controls and school fixed effects; and results on pupil level data include individual controls (see Table 3)

Table B3: Difference-in-difference estimates – Southwark			
	English Key Stage 2 results	Math Key Stage 2 results	Science Key Stage 2 results
Pupil level data – Percentile score	2.792	1.124	-0.339
	(2.769)	(2.167)	(2.516)
School level data			
% Level 3 and above	-1.955	-1.021	-1.962
	(1.949)	(1.956)	(1.834)
% Level 4 and above	0.110	1.895	-0.514
	(3.338)	(3.083)	(2.513)
% Level 5 and above	1.870	-2.757	-1.664
	(3.478)	(2.944)	(3.729)

Note: Standard errors in parentheses (clustered by school). *** p<0.01, ** p<0.05, * p<0.1; all estimates include school controls and school fixed effects; and results on pupil level data include individual controls (see Table 3)

Table B4: Difference-in-difference estimates – Tower Hamlets			
	English Key Stage 2 results	Math Key Stage 2 results	Science Key Stage 2 results
Pupil level data – Percentile score	-2.895	-2.550	-2.231
	(2.946)	(2.466)	(2.931)
School level data			
% Level 3 and above	-0.533	-0.512	0.588
	(2.212)	(2.278)	(2.235)
% Level 4 and above	-0.883	-4.103	-1.070
	(3.185)	(2.927)	(2.996)
% Level 5 and above	-6.012	0.0352	-3.501
	(4.289)	(3.313)	(3.851)

Note: Standard errors in parentheses (clustered by school). *** p<0.01, ** p<0.05, * p<0.1; all estimates include school controls and school fixed effects; and results on pupil level data include individual controls (see Table 3)

Table B5: Difference-in-difference estimates – Newham

	English Key Stage 2 results	Math Key Stage 2 results	Science Key Stage 2 results
Pupil level data – Percentile score	-3.759	0.731	-0.352
	(2.704)	(2.295)	(2.851)
School level data			
% Level 3 and above	0.505	0.170	0.649
	(2.174)	(2.075)	(2.032)
% Level 4 and above	0.235	3.085	0.445
	(3.379)	(3.152)	(2.884)
% Level 5 and above	-7.532**	-3.813	-1.816
	(3.627)	(2.864)	(4.024)

Note: Standard errors in parentheses (clustered by school). *** p<0.01, ** p<0.05, * p<0.1; all estimates include school controls and school fixed effects; and results on pupil level data include individual controls (see Table 3)

Table B6: Difference-in-difference estimates – Placebo year 2002-2003

	English Key Stage 2 results	Math Key Stage 2 results	Science Key Stage 2 results
Pupil level data – Percentile score	-2.661**	0.769	0.415
	(1.150)	(1.216)	(1.418)
School level data			
% Level 3 and above	-0.398	-0.834	-0.487
	(0.993)	(1.228)	(1.193)
% Level 4 and above	-2.045	0.812	-0.682
	(1.435)	(1.687)	(1.460)
% Level 5 and above	-0.664	2.446	0.721
	(1.710)	(1.560)	(2.047)

Note: Standard errors in parentheses (clustered by school). *** p<0.01, ** p<0.05, * p<0.1; all estimates include school controls and school fixed effects; and results on pupil level data include individual controls (see Table 3)

Table B7: Difference-in-difference estimates – Placebo year 2003-2004

	English Key Stage 2 results	Math Key Stage 2 results	Science Key Stage 2 results
Pupil level data – Percentile score	-0.990	0.805	0.524
	(1.274)	(1.151)	(1.384)
School level data			
% Level 3 and above	-0.665	-0.954	-0.382
	(1.135)	(1.334)	(1.279)
% Level 4 and above	-1.879	1.414	-1.492
	(1.623)	(1.650)	(1.594)
% Level 5 and above	-0.916	1.125	2.653
	(1.629)	(1.480)	(2.010)

Note: Standard errors in parentheses (clustered by school). *** p<0.01, ** p<0.05, * p<0.1; all estimates include school controls and school fixed effects; and results on pupil level data include individual controls (see Table 3)

Table B8: Difference-in-difference estimates – Wider control group			
	English Key Stage 2 results	Math Key Stage 2 results	Science Key Stage 2 results
Pupil level data – Percentile score	2.842	-0.0695	2.715
	(2.109)	(2.014)	(2.382)
School level data			
% Level 3 and above	0.514	0.290	-0.173
	(1.537)	(1.599)	(1.441)
% Level 4 and above	3.931*	1.482	2.057
	(2.332)	(2.764)	(2.707)
% Level 5 and above	0.773	0.632	6.147*
	(3.069)	(2.707)	(3.478)

Note: Standard errors in parentheses (clustered by school). *** p<0.01, ** p<0.05, * p<0.1; all estimates include school controls and school fixed effects; and results on pupil level data include individual controls (see Table 3); the LEAs included in the control are Lambeth, Lewisham, Southwark, Tower Hamlets, Wandsworth, Bexley, Croydon, Kingston upon Thames, Merton, Newham, Richmond, Sutton

Appendix C: Robustness checks for results on absenteeism

Table C1: Difference-in-difference estimates – Placebo LEA			
	Authorized absenteeism	Unauthorized absenteeism	Total absenteeism
Lambeth	-0.795**	-0.369	-1.164***
	(0.335)	(0.263)	(0.397)
Lewisham	-0.301	0.271	-0.0293
	(0.292)	(0.206)	(0.352)
Southwark	-0.482*	-0.376	-0.857***
	(0.274)	(0.260)	(0.318)
Tower Hamlets	1.448***	-0.202	1.246**
	(0.392)	(0.212)	(0.494)
Newham	0.0953	0.734***	0.829***
	(0.255)	(0.169)	(0.279)

Note: Standard errors in parentheses (clustered by school). *** p<0.01, ** p<0.05, * p<0.1; all estimates include school controls and school fixed effects; (see Table 3)

Table C2: Difference-in-difference estimates – Placebo year			
	Authorized absenteeism	Unauthorized absenteeism	Total absenteeism
School year 2002-2003	0.0416	-0.0189	0.0227
	(0.219)	(0.175)	(0.308)
School year 2003-2004	0.278	-0.186	0.0925
	(0.198)	(0.150)	(0.247)

Note: Standard errors in parentheses (clustered by school). *** p<0.01, ** p<0.05, * p<0.1; all estimates include school controls and school fixed effects; (see Table 3)

Table C3: Difference-in-difference estimates – wider group of control LEAs

	Authorized absenteeism	Unauthorized absenteeism	Total absenteeism
Greenwich x post-2005	-0.664***	-0.0476	-0.712**
	(0.248)	(0.241)	(0.317)

Note: Standard errors in parentheses (clustered by school). *** p<0.01, ** p<0.05, * p<0.1; all estimates include school controls and school fixed effects; (see Table 3); the LEAs included in the control group are: Lambeth, Lewisham, Southwark, Tower Hamlets, Wandsworth, Bexley, Croydon, Kingston upon Thames, Merton, Newham, Richmond, Sutton