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Impacts of discretionary universal free school meal schemes on primary school children's education attainment and school absence: A natural experiment study in England

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ABSTRACT

Discretionary Universal Free School Meal (UFSM) schemes for 4-11-year-olds were implemented in four local authorities with high child poverty levels in London, UK. The schemes were initiated between 2009/10 and 2014/15. The first scheme was evaluated as part of a national 2-year pilot. The present study concerns the first six years of all four schemes. In addition, we report on the longer-term effects (7+ years) for two of the schemes while the others were interrupted by COVID-19. The intention-to-treat impacts on z-score standardised attainment scores (reading, mathematics) and school absence in 10-11-year-olds were studied in a natural experiment design. We used a dynamic difference-in-differences approach with matched controls in sociodemographically similar neighbourhoods elsewhere in London. UFSM provision was on average not significantly associated with attainment nor absence during the initial six years of the schemes. However, scheme effects differed by local authority with the two longest running schemes showing positive results for reading and mathematics as secondary outcomes. Further studies are needed to better understand the mechanisms, how the schemes impact on the school environments, and how they may be improved.

1. Introduction

Free school meal (FSM) provision has historically been introduced in times of stark inequalities and food insecurity for

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philanthropical reasons and to foster learning (Keith, 2020; Lundborg et al., 2022; School Meals Review Panel, 2005). Means-tested FSM provision specifically became a statutory duty for local authorities in the UK in 1944 to address problems with hunger and malnutrition. In recent decades, some local authorities have implemented their own universal FSM schemes (Department for Education, 2013; Impact on Urban Health, 2022). The policy goals of these more recent schemes have notably expanded to influence diet quality, food skills, dietary inequalities (Department for Education, 2013; Haney et al., 2022; Impact on Urban Health, 2022), diet-related healthcare needs in children (Holford & Rabe, 2022), and healthy weight trajectories through the life course (Simmonds et al., 2017). A recent cost-benefit analysis anticipated wider benefits, such as higher lifetime earnings, reduced economic burden on families, reduced burden on healthcare systems, more sustainable food systems, and local job creation in catering (Impact on Urban Health, 2022).

In most of England, means-tested FSM is only offered to families on very low incomes in receipt of income benefits. The threshold for means-tested eligibility (£7,400 per household after tax) is considered to be overly restrictive, as the income of many families who are eligible for other income benefits, notably Universal Credit, may exceed this threshold (Impact on Urban Health, 2022; Yang et al., 2022). Many low-income families with incomes just above this threshold will be particularly hard hit in times of rising living costs. Paradoxically, however, not all families who are eligible for means-tested FSM apply to take advantage of this benefit. The reasons for not registering could include many factors such as lack of information, language barriers, that it requires parents' agency, stigma, as well as child/parent perception of the offer in terms of quality, quantity, variety, cultural appropriateness, or special dietary requirements (Sellen et al., 2018).

State-funded schools have a separate interest in families registering for means-tested FSM because it is directly linked to the amount of supplementary funding available to schools, referred to as the Pupil Premium (Carpenter et al., 2013). Children who are eligible for means-tested FSM and whose parents have registered for it will be referred to as having 'FSM status' from here onwards.

Discretionary Universal Free School Meal schemes (UFSM), the focus of this study, were introduced for all primary school children aged 4-11 years at different time points between 2009/10 (September 2009 to July 2010) and 2014/15 in four local authorities in Greater London: Newham, Islington, Southwark, Tower Hamlets (Department for Education, 2013; Impact on Urban Health, 2022) (Table 1). The London Borough of Newham, which initiated UFSM for all primary school pupils in 2009/10, decided to continue the offer based on findings from a public consultation (London Borough of Newham, 2021a, 2021b), maintaining that UFSM saves families money (£500 per child per annum), improves diets, food habits, child development, and education, addresses complex issues around food insecurity during financial downturns, and improves 'food equality' and social capital (London Borough of Newham, 2021a).

More widely, state-funded Universal Infant Free School Meals (UIFSM) were introduced across England in 2014/15; offering free lunch to children in the first three years of primary school (aged 4-7-years, Reception and Year 1-2) (Table 1). From that year onwards, the four discretionary schemes were funding the meals for Year 3-6 children only (aged 7-11 years).

The Mayor of London announced in February 2023 an emergency budget to extend the cover of costs of offering free school meals to all primary school pupils in London in 2023/24 (GLA, 2023). The decision was primarily taken in response to the cost-of-living crisis and to address food insecurity. The funding has since been extended to 2024/25(GLA, 2024). The subsidy per meal was at the same time increased to £3.

The nutritional quality of school food has in principle been regulated by government standards in England since 2001 although the Government has to date no means of monitoring compliance (Roberts et al., 2022). Standards were originally introduced in the 1940s but were abolished in the 1980s. Pilots instigated by the government's 'Levelling Up The United Kingdom' white paper focus on approaches to enforcing standards (initiated in December 2022) (Roberts et al., 2022). School catering companies are paid a fixed meal price and a survey carried out by one of the larger catering organisations suggest that the quality of the food is deteriorating in line with inflation and rising food costs (LACA, 2022). An independent review of the government's food strategy in 2021 asserted that many pupils find the food unappealing as only 39% of primary school pupils without means-tested FSM status take the meals (Dimbleby, 2021). Providing pupils with nutritious and acceptable meals is thus challenging in the absence of government monitoring, absence of enforcement of standards, absence of standards that go beyond nutritional value, and more so in times of high inflation and rising food costs due to market forces.

It is important to note that children spend a significant part of their day at school and that UFSM is a way to ensure that they – not least in times of rising living costs and food insecurity – can receive meals at school for free. The Commissioner for Human Rights of the Council of Europe recently called on the UK to address child poverty and food insecurity (Mijatovic, 2022). UFSM provision was listed

Table 1
Universal Free School Meal (UFSM) schemes in England. All pilots were extended until the commencement of the full schemes with no gaps. Year of treatment initiation was the first full school year of exposure, i.e. if a scheme started in March, exposure was only classed as such from the following school year.

Year 6 treatment initiation (school year ending)	Scheme names	Scheme Start
2010	Newham [Reception-Year 6]; Islington Pilot [Reception-Year 6] in 6 schools	Sep 2009
2011	Islington Non-Pilot [Reception-Year 6]	Mar 2010
2012	Southwark Pilot [Reception-Year 6] in 10 schools	Jan 2011
2014	Southwark Rollout [Reception-Year 1]	Sep 2011
	Southwark Rollout [+Year 2-4]	Sep 2012
	Southwark Rollout [+Year 5-6]; Tower Hamlets [Reception-Year 2]	Sep 2013
2015	Tower Hamlets [+Year 3-6]; National UIFSM [Reception-Year 2]	Sep 2014

Source: Freedom of Information Act 2000 requests to Greater London Authority and each of the four local authorities, Nov 2022-Jan 2023.

as one of the key measures for addressing structural barriers for children. The Commissioner mentioned a report by Child Poverty Action Group (CPAG), which estimated that 1 in 3 children living in poverty in England in 2022 (N=800,000) did not qualify for means-tested FSM. The CPAG report based their calculations on child poverty rates (after housing costs). Institute of Fiscal Studies (IFS) and Impact on Urban Health (IUH) have independently analysed the costs and benefits associated with the FSM offer. These included different scenarios of extending the current offer using more generous income thresholds as well as offering UFSM to all primary (4-11-year-olds) or both primary and secondary schools (4-16-year-olds) (Cribb et al., 2023; Impact on Urban Health, 2022). The IUH report highlighted that the value of monetised benefits is likely to exceed the costs in these scenarios. Different physical and behavioural links have been proposed between food provision and education outcomes (Belot & James, 2011; Cohen et al., 2016; Impact on Urban Health, 2022; Oostindjer et al., 2017). First, investing in school food provision could improve attendance either by making the school environment more attractive or because the children would be healthier and miss fewer days off school. Greater attendance would then lead to better attainment (Belot & James, 2011). Second, the food itself could prevent undernutrition and make children concentrate and learn better (Oostindjer et al., 2017). Third, qualitative improvements to the nutrition could mean that children would better develop and maintain the brain functions needed for cognition and concentration which in turn would lead to better attainment (Belot & James, 2011; Cohen et al., 2016; Oostindjer et al., 2017). Fourth, the diet could reduce aggressive behaviours and indirectly improve attainment (Belot & James, 2011). Fifth, a better diet could mean that fewer children would struggle with social inclusion due to an unhealthy weight. Healthy weight could in this way be another pathway to better attainment (Belot & James, 2011). Sixth, families could theoretically use the money saved on school food to improve the diet outside school with positive consequences for health and learning (Belot & James, 2011; Impact on Urban Health, 2022). Finally, behavioural changes that are more conducive to learning for individuals may spill over to peers (Belot & James, 2011; Oostindjer et al., 2017).

1.1. Existing evidence and study rationale

Only a few studies have to date evaluated the potential impact of UFSM on quantitative outcomes such as educational attainment and school absence in England (Department for Education, 2013; Holford & Rabe, 2022, 2024; Impact on Urban Health, 2022). Early findings from 2-year pilots conducted in 2009/10-2010/11 showed improved FSM uptake, reduced consumption of crisps (unhealthy snack) at lunch time and during the day as a whole, and improved educational attainment (English, maths), especially, in children from low-income families (Department for Education, 2013). In contrast, no changes were found for body mass index (BMI) or school absence in these pilots. A study of the impact of UIFSM in England found a reduction of BMI in 4-5-year-olds during their first year at school (Holford & Rabe, 2022). A study of the impact of the discretionary UFSM schemes in London also found a small reduction in obesity prevalence for both 4-5 and 10-11-year-olds compared to schools in London and across England without UFSM (Holford & Rabe, 2024). The same study found a statistically significant improvement (increase of approximately .04 standard deviation) in reading and maths test scores at the end of Year 6 compared to children in other London schools without UFSM. A similar effect was found when comparing to the rest of England, although only for reading. The improvement was observed for both children with and without FSM status. Internationally, a systematic review of 47 studies found varied associations of universal school meal provision with uptake, diet quality, food security, attainment, and savings for low-income households (Cohen et al., 2021). In most studies, there was either no effect or a reduction in BMI. The results for school absence were mixed.

Data from the national pilot study show that most pupils with means-tested FSM status continued taking the meals as before, whereas pupils without means-tested FSM status were more likely to start taking the meals with the intervention (Department for Education, 2013; Holford & Rabe, 2024). The group without means-tested FSM status receive or can receive transfers in terms of school food and cost savings for the families, while the group with means-tested FSM status could benefit in other ways, e.g. if possible to remove the stigma of receiving FSM as well as from changes in the school environment and associated peer effects. An unintended consequence of the intervention is however that it changes the incentives for families eligible for means-tested FSM to register for it once the meals are available to all for free. Equally, some families could feel easier about registering once it becomes less obvious who in the school canteen is eligible for the benefit.

We conducted an intention-to-treat natural experiment study of the impacts of UFSM on Year 6 (10-11-year-olds) school populations in state-funded schools in the four local authorities with this intervention, through comparison with children in state-funded schools in areas of London that matched with similar characteristics, but that did not provide additional free school meals to all

Table 2
Discretionary Universal Free School Meal (UFSM) study outcomes.

For Year 6 pupils (age 10-11 years) in intervention areas (with UFSM) relative to matched comparison areas (without UFSM) between 2007 and 2019, we will examine changes overall and by means-tested FSM status in:

Primary outcomes – Early-stage (first 6 years of the schemes where pupils have been exposed for 1-6 years in total)

1. Key Stage 2 (KS2) educational attainment in reading (standardised score).
2. KS2 educational attainment in mathematics (standardised score).
3. School absence.

Secondary outcomes – Late-stage (7-10 years of the schemes where the pupils have been exposed for their entire school career)

1. KS2 educational attainment in reading (standardised score).
2. KS2 educational attainment in mathematics (standardised score).
3. School absence.

NB: Only the two earliest schemes contributed fully to the late-stage post-intervention effects.

children. Pupils with and without means-tested FSM status were studied in parallel as two groups likely to be affected differently by the intervention. The first scheme, Newham, was evaluated as part of a national 2-year pilot (Department for Education, 2013). The present study primarily concerns the first six years of all four schemes. In addition, we report on the longer-term effects (7-10 years) for two of the schemes while the others were interrupted by COVID-19. This is not to say that the longer-term effects are less important only that we do not have the data to fully evaluate them.

The primary aim of the study was to assess the impact of discretionary UFSM schemes on Year 6 primary school children (10-11-year-olds)'s educational attainment (reading, maths) and school absence overall and by means-tested FSM status (Table 2). The null hypotheses are that UFSM has no impact on attainment (reading, maths) or absence.

The current study overlaps with Holford & Rabe (2024). Both studies assess impact of UFSM in the four front-runner local authority schemes in London, initiated 2009/10-2014/15, and both use a staggered Difference-In-Differences (DID) natural experiment design (Callaway & Sant'Anna, 2020; Craig et al., 2017; Cunningham, 2021). A difference between the two studies is how the counterfactual was defined. In setting this study up as a natural experiment we defined the counterfactual as pupils attending schools in local authorities without UFSM schemes and with residence in socio-demographically similar neighbourhoods in London (matched controls). Our secondary control method was pupils attending schools in local authorities without UFSM in London. The latter is the control strategy used by Holford & Rabe (2024). They used a different estimand that has been found to produce similar results with simulated data (Wang et al., 2024).

2. Material and methods

2.1. Participants

All Year 6 pupils registered in the Spring school census (in January) in state-funded schools in Greater London between 2006/07 and 2018/19 were studied. All pupil characteristics were taken from the Spring census accordingly. School cohorts were identified by attendance of schools in the local authorities with UFSM. The study used secondary data from the National Pupil Database (NPD), which contains data on all individuals in state-funded schools in England (Jay et al., 2018). Children attending privately funded schools were thus not covered in this study. The proportion of children attending private primary or secondary schools in London was 10.3% in 2019 (Department for Education, 2024). The equivalent proportions from the four intervention areas were 3.7% in Islington, 1.4% in Newham, 5% in Tower Hamlets, and 11.6% in Southwark (Department for Education, 2024). The NPD data undergo rigorous quality assurance prior to publication (Jay et al., 2018); however, we carried out additional checks of data completeness, consistency, and outliers. Any changes have been justified and documented in syntax files and a data flow diagram (Supplementary materials, Table S1-6).

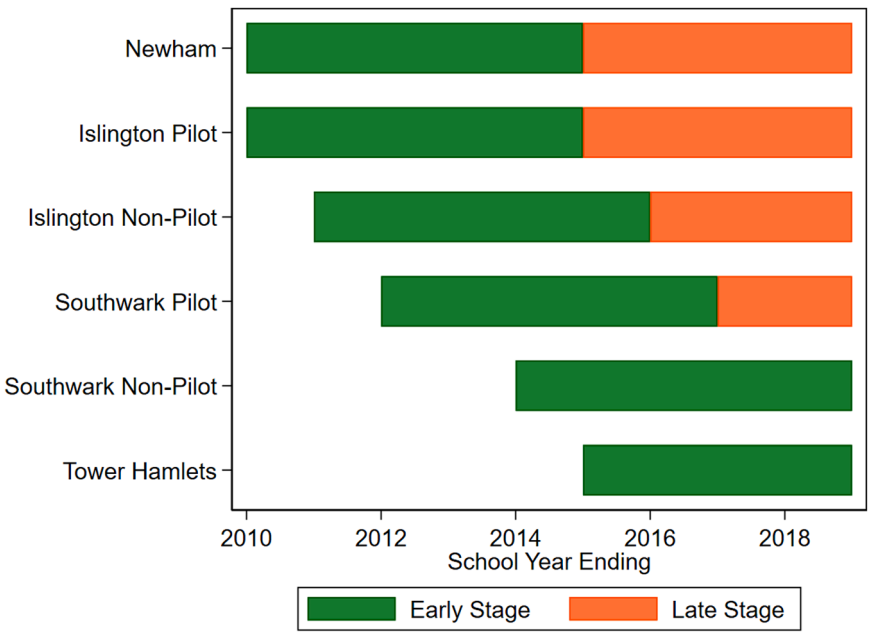

Fig. 1. Universal Free School Meal (UFSM) scheme timeline showing the end of school years for Year 6 that bracket the early (first 6 years) and late stage (7+ years) of the schemes.

2.2. Interventions

Four local authorities in Greater London introduced discretionary UFSM in their primary schools at different time points in 2009/10-2014/15 (Table 1, Fig. 1). Notably, they were among the eight local authorities in England with the highest child poverty rates (after housing costs) in 2018/19 (Stone, 2023): Tower Hamlets (55.4%, Rank 1), Newham (50.9%, Rank 2), Southwark (43.2, Rank 6), Islington (42.3%, Rank 8). UFSM means that a free lunch is on offer for any child who wants it regardless of the income levels of the family. Details of the UFSM schemes were obtained from Greater London Authority and the four local authorities (Table 1). All pilots were extended until the commencement of the full schemes with no gaps in provision.

COVID-19 disrupted intervention delivery and outcome measurements in 2019/20-2020/21. The outcomes themselves were also affected by the pandemic and FSM eligibility increased due to widespread financial hardship (Roberts et al., 2022). For these reasons and due to lack of data, we have limited the impact evaluation to the years prior to the COVID-19 pandemic.

We refer to the control group as 'Never treated' meaning they were never exposed to UFSM. From 2014/15, Reception-Year 2 were exposed to UIFSM nationally. This is a study of Year 6 cohorts. However, it should be acknowledged that the Year 6 controls for the last cohort (first school year ending 2013), were exposed to UIFSM for a single year when they were in Year 2. We have pragmatically included this cohort since they were only exposed to a universal scheme for one year out of their seven years in primary school and that the effects are measured dynamically as averages over many different cohorts and time periods.

2.3. Statistical methods

We used a dynamic, multiple time period DiD approach with individual level data and matched controls (3 controls:1 intervention) elsewhere in London (Callaway & Sant'Anna, 2020; Rios-Avila et al., 2023). This method breaks down the analysis into a series of classic 2×2 DID tables comparing treated before/after with controls before/after for treated groups with different starting points and for different time periods. The overall effect is a weighted average of these sub-analyses, e.g. giving more weight to larger schemes than smaller schemes. It is a dynamic method that also allows units that at a given time point are not yet treated to be part of the control pool when appropriate. The primary controls in our control strategy were pupils in propensity-score matched control areas consisting of Lower layer Super Output Areas (LSOA; approximately 1,700 average population). Additional controls (secondary controls in the control strategy) were pupils in never-treated schools. During the study period UFSM schemes were uniquely based in London. Taking unmeasured characteristics into consideration, the controls were restricted to London on a similarity-by-proximity principle (Tobler, 1970). Another reason for this design, was to leave out the so-called 'London effect' otherwise found in national studies of attainment (Ross et al., 2020). The matching used pre-intervention neighbourhood characteristics from the 2011 Census, and Indices of Multiple Deprivation (IMD) at LSOA level (Department for Communities and Local Government, 2015; ONS, 2015) (Table S3). Among these, we included the proportion of 0-15-year-olds in income deprived households (Income Deprivation Affecting Children Index – IDACI). Different matching algorithms, i.e. propensity score or multivariate distance (Mahalanobis), were compared *a priori* using matching diagnostics (Jann, 2020). Multivariate distance resulted in the best balance across the matching variables and minimised standardised differences (Table S3). We have chosen to match on small area neighbourhood characteristics at LSOA level rather than at e.g. school-level as LSOA have smaller denominators and are hence a more precise measurement of socio-economic status (Openshaw, 1984). School-level clustering was however taken into account when calculating the standard errors.

Year of treatment initiation was the first full school year of exposure, i.e. if a scheme started in March, exposure was only classed as such from the following school year (Table 1).

We report Average Treatment effects on the Treated (ATT) for the early versus late stage of the schemes as well as by calendar year. The *early stage* is defined as the first six years of the intervention where Year 6 pupils year by year are increasingly exposed to UFSM during their school career. All four schemes (including pilots) contributed fully to the early-stage effects except for Tower Hamlets pupils who could only be observed for five of those six post-intervention years due to COVID-19 disruptions. The *late stage* is defined as seven and more years of intervention (in effect, 7-10 years), where Year 6 pupils have been exposed for their entire school career. Only Newham and the Islington pilot schemes contributed fully to the late-stage estimate. In addition, the Islington non-pilot and Southwark pilot scheme contributed to the first three and two years of that 4-year period, respectively.

The exam results for reading and maths were z-score standardised within each school year. This was to omit variation in how difficult or easy an exam happened to be one year to the next. School absence was studied as the ln-transformed (natural logarithm) percentage of sessions absent for each individual, where a session corresponds to either the morning or afternoon register of a normal school day. The treatment effect of the ln-transformed absence outcome was reported as: $ATT\% = -100*(1- e^{ATT})$.

There are different assumptions that apply to the DID design. The most commonly reported are parallel trends assumption, no anticipation effect, and no contamination of the treatment allocation (Cunningham, 2021). All schemes have at least three years of data prior to the intervention and a joint pre-trends test for this time period was carried out in support of the parallel trends assumption (Cunningham, 2021). Any anticipation effects were assessed by checking whether the effect in the year before the intervention was significant. No contamination of the treatment allocation is inherently harder to check in a natural experiment. It could be hypothesised that families ineligible to FSM elsewhere could actively move into intervention areas or move their children to schools in intervention areas from neighbouring areas. However, we do not have data on such moves to verify this.

The work was undertaken in the Office for National Statistics (ONS) Secure Research Service using data from ONS and other owners and does not imply the endorsement of the ONS or other data owners.

2.4. Sensitivity checks

As a sensitivity check of bias potentially introduced by matching, we also conducted the Difference-in-Differences (DiD) analysis without matching, i.e. using Never-treated controls. There are examples in the literature that warrant this additional check of the matching (Webster-Clark et al., 2021). Various sensitivity checks were conducted such as *placebo in space* (swapping treatment status of areas with a scheme with a control area at random) and studying any effects over calendar time in addition to intervention time. The latter was to check for potentially confounding effects of changes to the curriculum and exams from 2016 onwards (Department for Education, 2016). In the current state of software development for staggered designs it is not possible to adjust for time-varying co-variates (Callaway & Sant'Anna, 2020). As a robustness check, we therefore also carried out single time period DiD for the first six years of each scheme relative to never-treated areas and solely report the changes in attenuation between unadjusted analyses and analyses adjusted for time-varying covariates (gender, non-White ethnicity, and English as alternative language). The adjustment is justified on the grounds that it is a repeated cross-sectional study where the outcome between different years could be confounded by the sociodemographic composition alone or, worded differently, these sociodemographic variables are potential confounders on the pathway between pre- and post-intervention states of the outcome. It is at the same time assumed that treatment allocation is independent of these potential confounders.

2.5. Software

All data handling and analysis were carried out in Stata (version 17) (StataCorp, 2021) and documented in syntax files.

2.6. Study programme

This study has been designed to complement a qualitative evaluation exploring the factors influencing equitable healthy eating, uptake of UFSM and healthy whole school food approaches in primary schools by applying a focused ethnography centred on Tower Hamlets (Concha et al., 2024).

The study is part of the Tower Hamlets Health Determinants Research Collaboration (HDRC) partnership, a 5-year programme (2022-2027) to combat health inequalities by fostering better links between sectors and addressing wider determinants of health, enhancing data infrastructures, and strengthening an evidence-informed culture in the Council. Central to this programme is a cross-cutting theme of involving community organisations and local residents in a two-way dialogue about important issues that matter to them and discuss potential solutions.

Representatives from community organisations, the Council and the third sector have been involved in the study from conception to dissemination. Their involvement helped bringing in views from the local community. They facilitated a session with a community group (N=20) in Tower Hamlets in April 2023. The feedback from the group indicated that the research was regarded as important and aligned with the needs of local families and children. The group provided valuable insights, which we used to refine the theory of change model that underpinned the study. We are furthermore organising different activities within this partnership to reflect on the results of both the present quantitative study and the accompanying qualitative study.

Table 3
Baseline characteristics (school years ending 2007-2009) by Universal Free School Meal (UFSM) scheme and control groups. 'All schemes' column includes pilots. Abbreviations: standard deviation (SD). Data source: National Pupil Database, 2007-2019.

	Islington excl. pilot	Newham	Southwark excl. pilot	Tower Hamlets	All schemes	Matched controls	Never treated
Pupil characteristics							
Pupils per year (N)	1,447	3,691	2,131	2,585	10,721	27,816*	66,827
Girl%	48.8	49.8	48.4	48.9	49.1	49.0	48.9
Non-White ethnicity%	53.5	82.0	66.2	82.2	74.2	67.6	50.0
English as alternative language %	43.0	72.1	40.6	77.2	60.9	52.8	37.4
FSM status%	42.9	37.4	33.7	59.1	42.5	36.4	23.8
Pupil outcomes							
Reading score (SD)	-0.12	-0.23	-0.07	-0.11	-0.15	-0.14	0.02
Mathematics score (SD)	-0.10	-0.12	-0.09	-0.04	-0.10	-0.13	0.02
Absence%	5.6	4.6	5.0	4.6	4.8	5.2	5.0
Pupil area characteristics							
IDACI%	36.5	29.1	32.4	39.3	33.5	33.5	24.2
0-15-year-olds%	17.7	23.6	20.1	22.7	21.7	21.4	21.4
UK born%	63.3	47.4	60.0	58.1	55.7	55.9	65.6
Adults degree educated%	43.0	28.3	38.0	32.6	34.1	34.8	32.2

*) Unweighted count: 15,205

3. Results

3.1. Descriptive statistics

The schemes covered an average of 10,721 pupils per year of which 42.5% had means-tested FSM status in the 2007-09 baseline years (Table 3). The trends in reading and maths showed an improvement in attainment scores for some but not all schemes (Fig. 2,

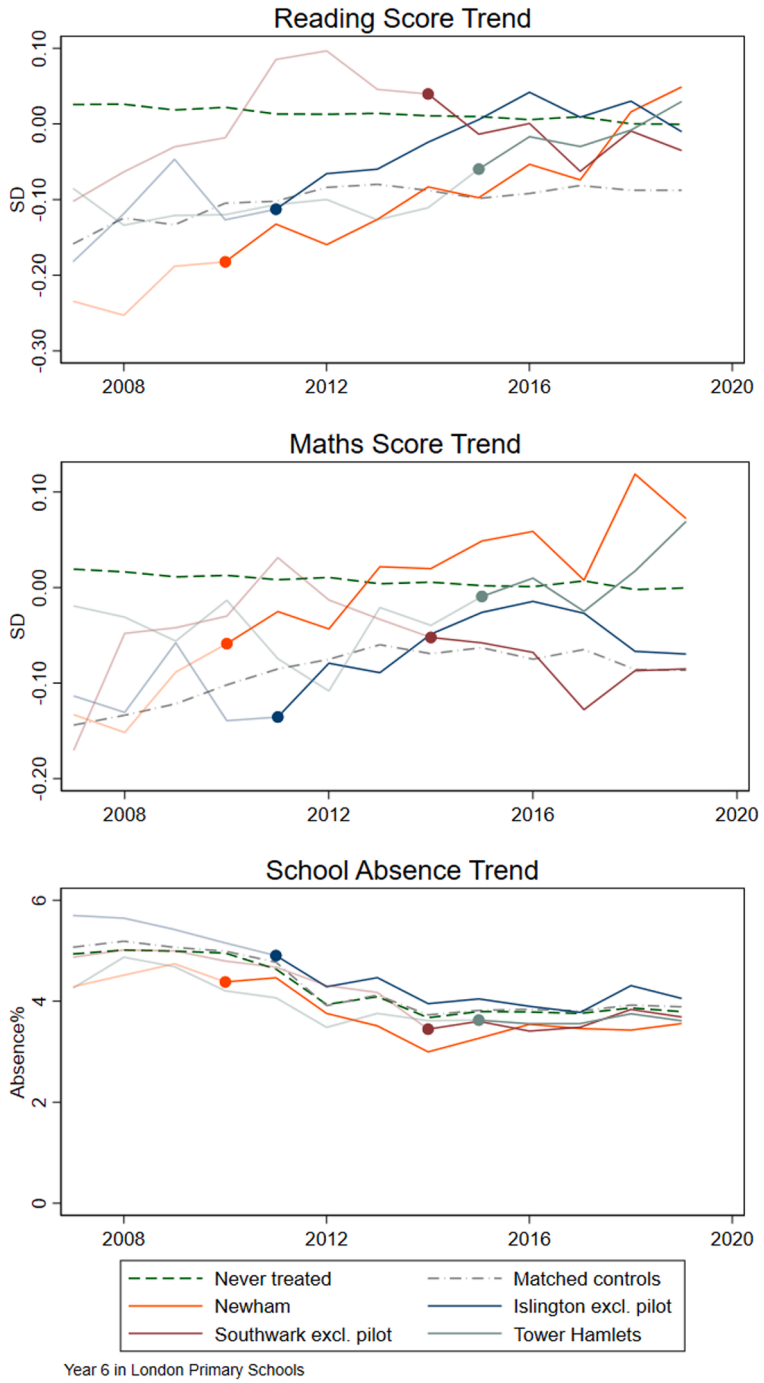

Fig. 2. Trends in Year 6 (aged 10-11 years) attainment outcomes (reading, mathematics) and school absence in control areas and areas with Universal Free School Meal (UFSM) in London, UK. The UFSM implementation year is marked with a dot for each intervention area. Data source: National Pupil Database, 2007-2019.

Figure S1-2 for averages of underlying scores). The matched controls also showed an improvement at least in the earlier years (Fig. 2). The proportion of pupils with means-tested FSM status was generally dropping, especially from 2014 onwards, followed by a slight increase from 2018 onwards (Fig. 3).

3.2. Average treatment effect on the treated

All schemes contributed to the early-stage of UFSM, where the treated Year 6 cohorts were increasingly exposed to UFSM. This is the primary outcome. The earliest schemes furthermore contributed to the late-stage, where the treated Year 6 cohorts had been exposed to UFSM for their entire primary school career. The late-stage results are reported as secondary outcomes.

During the initial six years of the schemes, the impact of UFSM on attainment was heterogeneous with no overall, significant effect on reading (ATT .0323 standard deviations (95% confidence intervals -.0105;.0752), P-value=.139), maths attainment (.0261 (-.0124;.0646), P=.184), or absence (-2.15% (-5.69%;1.52%), P=.248) when compared to pupils in matched control areas (Table 4, Fig. 4).

The earliest schemes were associated with late-stage effects on reading (.1128 (.0248;.2008), P=.012) and maths (.0876 (.0031;.1722), P=.042), while no effect was found for absence (-.50% (-5.43%;4.68%)) (Table 4). Early-stage analyses by means-tested FSM status were not significant for any of the outcomes (Table 4). Late-stage analyses were significant for reading for both non-FSM status (.0984 (.0049;.1919), P=.039) and FSM status pupils (.1209 (.0139;.2279), P=.027).

The calendar-time breakdown showed significant attainment effects in the two latest years compared to controls (Fig. 5).

3.3. Parallel trend assumption and no anticipation effect

The pre-trend test of the parallel trends assumption held for all outcomes except the absence outcome for FSM status pupils (Table S7). The pre-intervention absence data for this sub-group were relatively noisy. The assumption would still hold 1-2 years before the intervention. The observed pre-trend effects are however relatively small and the post-intervention effects are not significant. So, even if the parallel trend assumption did not hold for this particular outcome, it is not used to prove an effect in any case.

No effects were found to be significant a year before the intervention, so the no anticipation effect assumption held (Fig. 4).

3.4. Placebo in space check

The purpose of the placebo in space check, was to see if similar results (especially, positive) could be generated even with an erroneous treatment allocation (Table S8). The analysis did not find any significant results or at least only for the overall absence outcome, which generally was noisier than other outcomes and did not lead to any significant results in the main analysis.

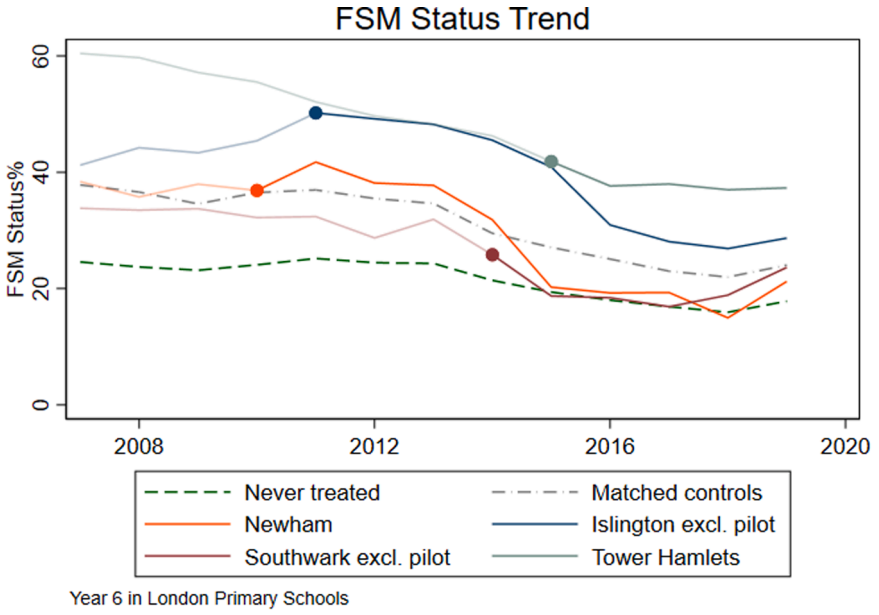

Fig. 3. Trend in Year 6 (aged 10-11 years) means-tested FSM status in control areas and areas with Universal Free School Meal (UFSM) in London, UK. The UFSM implementation year is marked with a dot for each intervention area. Data source: National Pupil Database, 2007-2019.

Table 4
Universal Free School Meal (UFSM) Average Treatment effect on the Treated (ATT) by outcome, intervention stage, and control group (95% confidence intervals) in Year 6 pupils in London (aged 10-11 years). Early-stage is the average of the first 6 years of intervention and late-stage is of 7-10 years of intervention. Only the first implemented schemes contribute to the late-stage averages. The units for reading and mathematics are standard deviation and the unit for absence is percent effect change (ATT%). The Bonferroni multiple testing 95% threshold for the nine primary outcomes listed under Treated vs Matched Controls/Early-stage is .05/9=.006. Data source: National Pupil Database, 2007-2019.Significant results are highlighted in bold face.

	Treated vs Never-Treated				**Treated vs Matched Controls**			
Outcome	Early-stage	P	Late-stage	P	Early-stage	P	Late-stage	P
All pupils								
Reading	**.0498** (.0096;.0899)	.015	**.1631** (.0807;.2455)	<.001	.0323 (-.0105;.0752)	.139	**.1128** (.0248;.2008)	.012
Mathematics	**.0437** (.0069;.0805)	.020	**.1307** (.0501;.2113)	.001	.0261 (-.0124;.0646)	.184	**.0876** (.0031;.1722)	.042
Absence	-1.87 (-5.26;1.63)	.290	-.27 (-4.85;4.53)	.910	-2.15 (-5.69;1.52)	.248	-.50 (-5.43;4.68)	.846
Non-FSM status pupils								
Reading	.0252 (-.0179;.0683)	.252	**.1301** (.0429;.2172)	.003	.0201 (-.0261;.0663)	.394	**.0984** (.0049;.1919)	.039
Mathematics	.0292 (-.0129;.0712)	.174	**.1080** (.0193;.1966)	.017	.0185 (-.0258;.0628)	.414	.0697 (-.0240;.1634)	.145
Absence	-1.08 (-4.74;2.72)	.570	.37 (-4.50;5.47)	.885	-1.38 (-5.28;2.68)	.499	-.31 (-5.60;5.26)	.910
FSM status pupils								
Reading	**.0570** (.0036;.1104)	.036	**.1485** (.0506;.2463)	.003	.0408 (-.0165;.0981)	.163	**.1209** (.0139;.2279)	.027
Mathematics	**.0460** (.0003;.0912)	.048	.0764 (-.0159;.1687)	.105	.0354 (-.0133;.0841)	.154	.0717 (-.0264;.1698)	.152
Absence	-2.50 (-7.04;2.27)	.298	2.73 (-4.41;10.38)	.464	-2.77 (-7.53;2.23)	.272	3.64 (-4.16;12.10)	.370

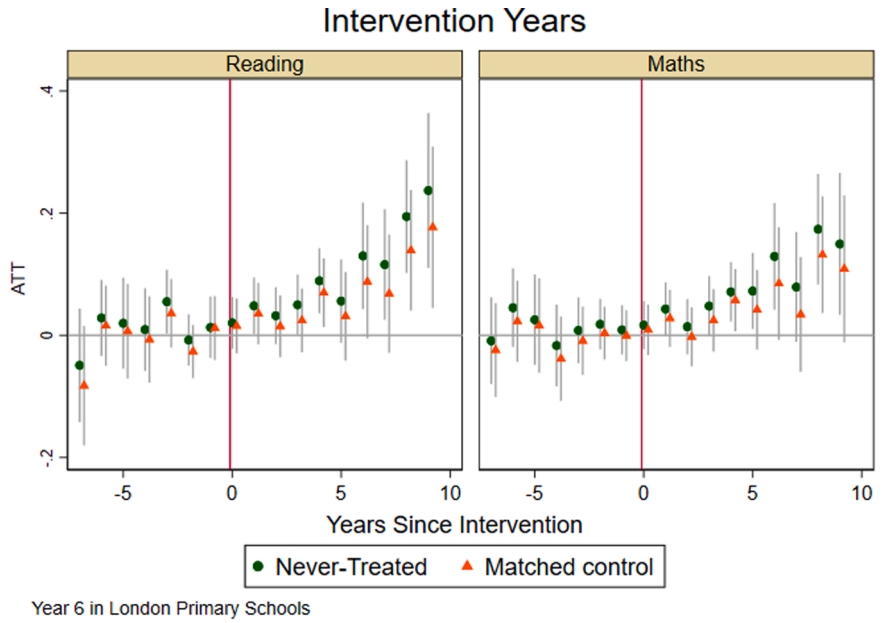

Fig. 4. Average Treatment effect on the Treated (ATT) of Universal Free School Meal (UFSM) on Year 6 (aged 10-11 years) reading and mathematics attainment over intervention years in London, UK. Data source: National Pupil Database, 2007-2019.

3.5. Time-varying co-variates check

The difference in attenuation in the single-time period DiD analyses adjusted and not adjusted for time-varying covariates were relatively small compared to the effects in the main analyses (Table S9). Adjusted outcomes would be more accurate, but we reason that it would only make a small change to the results, should the specific multiple time period method have been available.

4. Discussion

This study did not find a statistically significant impact of UFSM on reading, maths, or absence during the initial six years of the schemes (when pupils were increasingly exposed to UFSM – early stage) when compared to socio-demographically similar neighbourhoods (Table 4). The point estimates for these primary outcomes suggest a very small, statistically insignificant improvement in attainment (c. .03 standard deviations) and a very small, statistically insignificant reduction in absence (c. -2%). The two earliest schemes were associated with late-stage (pupils exposed to UFSM throughout their entire school career) effects on reading and maths,

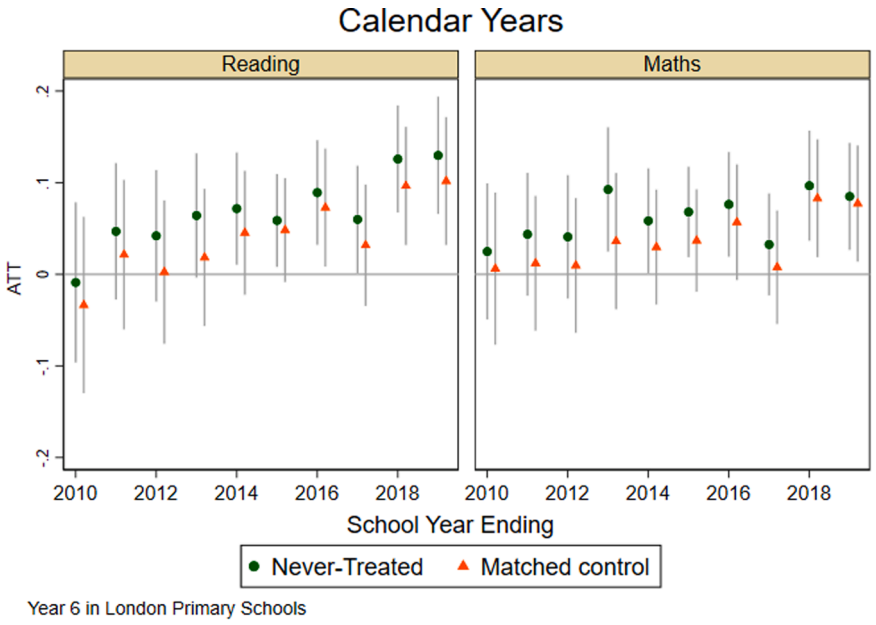

Fig. 5. Average Treatment effect on the Treated (ATT) of Universal Free School Meal (UFSM) on Year 6 (aged 10-11 years) reading and mathematics attainment over calendar years in London, UK. Data source: National Pupil Database, 2007-2019.

while no effect was found for absence. These findings were consistent when exploring the impact of UFSM by means-tested FSM status, where the analyses of the late stage of the two earliest schemes showed significant results for reading for both non-FSM status and FSM status pupils. The late-stage findings are interesting although we acknowledge that they are secondary outcomes since only the earliest schemes could be fully assessed due COVID-19 disruptions. To put the secondary findings into context, the overall late-stage effect on reading (approximately .11 standard deviations) is comparable to the effect of introducing the Literacy Hour in 1997-98 (.08 standard deviations) (Machin & McNally, 2004). The English UFSM pilot study notably found significant effects for attainment in English and maths, equivalent of two months' worth of progress (Department for Education, 2013). Interestingly, the Newham scheme was part of the English UFSM pilot and a scheme that contributed to the positive late-stage effects in this study.

A review of international studies reported mixed attainment and attendance effects from a diverse range of settings and interventions (Cohen et al., 2021). While the intervention studied here is a free lunch offer for primary school children, there are many examples of interventions focused on improving combinations of access and food quality as well as offers of free breakfasts alone or in combinations with free lunches. The present study appears to be in line with the findings of another recent study in terms of the magnitude of early-stage attainment improvements (approximately .04-.05 standard deviations; Table 4, Never-treated columns) when comparing to children in the rest of the London region (Holford & Rabe, 2024). A difference between the two studies is that the present study uses children residing in socio-demographically similar neighbourhoods elsewhere in London as the primary control strategy. The reason is that these neighbourhoods present a more likely counterfactual. As evident from the trend graphs, the matched control areas themselves saw an improvement in attainment (Fig. 2). The effects of the combined schemes with matched controls were hence smaller and ultimately not significant in the present study (Table 4). The four discretionary UFSM schemes present an important opportunity to measure the potential benefits on a range of outcomes. There is less statistical power to assess individual schemes, but late-stage results from the two earliest schemes show both the presence of scheme-level heterogeneity overall and significant effects on attainment. Based on just four schemes, it is difficult to know the factors behind the heterogeneity. Different hypotheses are possible. One hypothesis could be that the schemes were implemented differently and/or that some school populations were more amenable to change. It could be hypothesised further that local authorities well below the regional attainment average had the potential to catch up with the rest of the Greater London region, while local authorities closer to or above the average lacked the same potential. Another hypothesis for further investigation could be that UFSM coincided with other interventions specifically aimed at improving attainment in the local authorities that saw the greatest changes. We do not have specific evidence of any such co-occurring interventions although disentangling the effects of competing interventions is a common evaluation problem (Matthay et al., 2022).

It could be hypothesised that UFSM can have a positive impact on the wider school environment and associated peer effects on educational outcomes, e.g. by reducing the stigma otherwise associated with means-tested FSM status (Holford & Rabe, 2024). The fact that late-stage analyses found a positive association with reading for both pupils with and without means-tested FSM status while the intervention most tangibly only affected the latter, could be interpreted as support for this hypothesis (Holford & Rabe, 2024). Interestingly, the calendar-time breakdown showed marked better results for the UFSM schemes in the two latest years (Fig. 5). The calendar-time breakdown was planned to check whether the universal change in curriculum and tests from 2016 onwards (the last four years of the study period) could somehow have a distorting effect on the overall results. It is not clear what might have caused the more distinct effects in the two latest years, which comprises a mixture of schemes in early- and late-stage. A longer time series would have

been an advantage but unfortunately the following years were disrupted by COVID-19.

The present study did not find any associations between UFSM and school absence. This finding is consistent with another recent study in the same setting (Holford & Rabe, 2024), while a systematic review of international studies reported mixed results (Cohen et al., 2021).

What is clear from the present study is that attainment effects were mixed and heterogenous. We were not able to measure, or account for, the many contextual factors that make UFSM a complex, social intervention. For example, it is possible that findings might be influenced by the quality of the food (Cohen et al., 2021; Gatenby, 2011) (Figure S1-2). Many other factors may add complexity or heterogeneity too. Despite high uptake rates in the national 2-year pilot (Department for Education, 2013), the schemes could over time end up with lower uptake due to child and parent perception of the offer in terms of quality, quantity, variety, cultural appropriateness, or special dietary requirements (Sellen et al., 2018). The school food environments may at the same time not be equally supportive of all children.Ultimately, KS2 exams are intended to capture knowledge retained from being taught the curriculum and are not specifically designed as tests of cognitive ability (Strand, 2006). It is therefore possible that the KS2 tests are not sufficiently sensitive to confirm the otherwise well-known links between nutrition and cognition (Belot & James, 2011; Cohen et al., 2016; Oostindjer et al., 2017).

The objectives of the national FSM pilot funded by DfE in 2009/10-2010/11 included attainment and attendance outcomes. These goals are if not directly stated still implicit in the current guidance, e.g. in the school food guidance to school governors: "A great school food culture improves children's health and academic performance". With the findings from this study, we may ask whether the pathways between funding meals and 'producing' exam results and attendance records have been portrayed too simplistically. The short-term attainment effects found in both this and another recent study (Holford & Rabe, 2024) are very small and in our case not statistically significant. This does of course not preclude long-term effects or effects outside what KS2 exams can measure. We also wish to stress that this study only looked at a few of the many outcomes in the recent cost-benefit analysis, which also modelled future impacts until 2045 (Impact on Urban Health, 2022). Our findings that UFSM may have impacted positively on attainment in some but not all settings should motivate further studies. If there were ever any doubt, UFSM should in any case be approached as a complex social intervention (McGill et al., 2021). We therefore call for more mixed methods studies of how the intervention works to understand any context-specific enablers or barriers.

4.1. Limitations

School-level free school meal uptake data are collected in the school census about pupils with means-tested FSM status only. There is – in contrast - no recording of whether individual pupils claim and eat school meals and we accordingly studied the net effects of the intervention as intention-to-treat. Low uptake could weaken any effects although this cannot be studied directly due to lack of recording of individual data. This is a key limitation. We initially tried to at least obtain school- and local authority-level uptake data as actual counts or based on expenditure figures through Freedom of Information Act 2000 requests. One local authority had partial data at a single time point towards the end of the study period and stated that further enquiries at school level was unwanted. Another had school-level counts but only after the end of the study period. A third local authority reported local-authority-level expenditure figures, and the fourth reported that no data of any kind were available. The Newham scheme was part of the national UFSM pilot in 2009/10-2010/11 and conformingly reported uptake rates at 94% in the first school year and 92% in the second (Department for Education, 2013). We do not have data for other schemes or for whether the uptake rates in Newham were sustained during the remaining years of the study period.

Although addressed in the natural experiment design, it is inherently not possible to eliminate selection bias due to non-random allocation of UFSM. This is another important limitation for the interpretation of the results. The purpose of the natural experiment study is to make up for the fact that the intervention was not randomly assigned. In our design, children in socio-demographically similar neighbourhoods therefore act as controls.

We studied pupils with, versus without, means-tested FSM status as these two groups are likely to be affected differently by the policy. The UFSM schemes themselves could have changed the incentive for eligible families to continue registering for FSM. Yet the local authorities have strong financial incentives to actively prompt eligible families to register to reduce their share of the scheme costs and to boost the schools' main source of per capita Pupil Premium grant (introduced April 2011) (Department for Education, 2015). Early reports suggest that the majority of schools actively encouraged parents to register (Carpenter et al., 2013). The introduction of UIFSM in 2014/15 nonetheless led to a drop in pupils with FSM status not confined to the younger year groups (Fig. 3). One suggestion for this drop has been that many families no longer saw a need to apply (Sellen et al., 2018), although this argument only truly makes sense for pupils in Reception to Year 2. The income threshold for means-tested FSM eligibility was lowered in April 2018 (as part of the rollout of Universal Credit), although those eligible in April 2018 could retain their entitlement regardless of any future changes in their circumstances. This led to a net rise in pupils with FSM status in the following years (Department for Education, 2024) (Fig. 3). We acknowledge that while means-tested FSM status is a key marker of socio-economic disadvantage, it is in itself sensitive to co-occurring reforms in the wider school system.

The data on pupil characteristics came from the Spring school census. The data are a snapshot collected in January each year and may as such not be completely representative of the whole school year. We do however assume that this is unlikely to bias the results as this was the case for all study groups whether treated or not.

The control areas were matched *a priori* on variables at the neighbourhood level known to affect school outcomes. These included the proportion of households with children affected by income deprivation, population aged 0-15 years, adults with degree education, and native birth (Table S3). As a global gateway city, many local authorities in London are characterised by a diversity of people (Short

et al., 2000). For some country of birth can be a meaningful lens to study educational outcomes. There are also long-settled groups for which ethnicity or intersections between migration history and ethnic group might be a more appropriate lens (Byrne et al., 2020). It is acknowledged that the matching process covered some but not all intersections that could be of importance for educational inequalities and this is acknowledged as an area for further studies.

The KS2 attainment data planned for this study are relatively complete except for the school year ending 2010, where around a quarter of schools in England abstained from submitting the test results to Department of Education in a protest over the exams (Department for Education, 2010; Shepherd & Williams, 2010). This was the first post-intervention year for the earliest schemes, which might be different for many other reasons. We acknowledge that it is difficult to assess any impact the boycott might have had on the data. We at least report average effect over several years as the main results.

Since March 2018, schools in the most deprived local authorities in England have been able to join the national school breakfast club programme, which provides free breakfast (75% of costs covered from September 2022 onwards) (Department for Education, 2022). Media reports suggest the existence of many local, long-standing, and diverse initiatives and no reliable single data source has been identified to date. Any effects of UFSM may locally be masked or possibly enhanced by the existence of initiatives offering food at other times of the day. This is acknowledged as a limitation in the natural experiment design of the study.

State schools in England may vary in how successful they are in raising funds and attracting volunteers to improve the school environment. One study has e.g. shown an inverse correlation between the primary schools' fundraising and the catchment area deprivation (Body & Hogg, 2022). The controls in this study are children in similar neighbourhoods based on demographic variables and a child poverty measure (IDACI). We assume that the average school attributes reflect the catchment neighbourhoods in that regard.

5. Conclusion

This intention-to-treat natural experiment study carried out with data from four front-runner local authorities with high child poverty levels found that UFSM provision was not significantly associated with changes in KS2 reading and maths attainment nor absence during the initial six years of the schemes. However, improvements were observed for reading and maths – as secondary outcomes - for those who had experienced UFSM through the whole of their primary school years in areas that had implemented the scheme for longest. This is interpreted as variation in treatment effects between the different local authorities with schemes. Further studies are needed to better understand the mechanisms, how the schemes impact on the school environments, and how they may be improved. The assumed mechanism suggests that provision of nutritious meals aids attention and learning. Another pathway, especially for those with means-tested FSM status, could be that children benefit from an improvement in the school environment through peer effects. We were however unable to test this further due to a lack of available data on meal uptake. There is a need for further studies with accurate data on pupil-level uptake and longer-term follow-up to tease apart the potential effects of the actual consumption of school meals on these outcomes. The heterogeneity in the results should moreover motivate further studies of any context-specific enablers and barriers.

Authorship statement

Conceptualisation [JP, CD], Data curation [JP], Formal Analysis [JP], Funding acquisition [CD], Investigation, Methodology [JP, CD], Supervision [CD], Writing – original draft [JP], Writing – review & editing [MB, NC, CD, NF, MH, SJ, LM, OO, JP, AR, KS, VT, ST].

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CRediT authorship contribution statement

Jakob Petersen: Writing – original draft, Data curation, Methodology, Formal analysis, Writing – review & editing, Investigation, Conceptualization. **Maria Bryant:** Writing – review & editing. **Natalia Concha:** Writing – review & editing. **Nicola Firman:** Writing – review & editing. **Meredith K.D. Hawking:** Writing – review & editing. **Safia Jama:** Writing – review & editing. **Liina Mansukoski:** Conceptualization, Writing – review & editing. **Oyinlola Oyebode:** Writing – review & editing. **Alison Robert:** Writing – review & editing. **Katy Scammell:** Writing – review & editing. **Veronica Toffolutti:** Writing – review & editing, Conceptualization. **Simon Twite:** Writing – review & editing. **Carol Dezateux:** Writing – review & editing, Methodology, Funding acquisition, Supervision, Investigation, Conceptualization.

Declaration of competing interests

There are no conflicts of interest to declare.

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Data sharing and data availability

The data that support the findings of this study are available from Department for Education. Restrictions apply to the availability of these data, which were used under license for this study. Data are available from https://www.gov.uk/guidance/ apply-for-department-for-education-dfe-personal-data with the permission of Department for Education. Syntax files are published on Open Science Framework under the project entitled 'Free School Meals Natural Experiment' (DOI 10.17605/OSF.IO/2ZVGP).

Ethics statement

The protocol has been seen by Queen Mary University of London Research Ethics Committee (06 March 2023). Their assessment was that no ethical approval was needed due to the secondary nature of the data.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ijer.2025.102713.

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