



Association between distance to nearest supermarket and provision of fruits and vegetables in English nurseries



Thomas Burgoine^{a,*}, John A. Gallis^{b,c}, Tarra L. Penney^a, Pablo Monsivais^{a,2}, Sara E. Benjamin Neelon^{a,d}

^a UKCRC Centre for Diet and Activity Research (CEDAR), MRC Epidemiology Unit, University of Cambridge School of Clinical Medicine, Box 285, Institute of Metabolic Science, Cambridge Biomedical Campus, Cambridge CB2 0QQ, UK

^b Department of Biostatistics and Bioinformatics, Duke University Medical Center, 2424 Erwin Road, Suite 1102 Hock Plaza, Durham, NC 27710, USA

^c Duke Global Health Institute, Duke University, 310 Trent Hall, Durham, NC 27710, USA

^d Department of Health, Behavior and Society, Johns Hopkins University, 624 N Broadway, Baltimore, MD 21205, USA

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ABSTRACT

With 796,500 places available for children in England, pre-school nurseries could serve as an important setting for population-wide dietary intervention. It is critical to understand the determinants of healthy food provision in this setting, which may include access to food stores. This study examined the association between objective, GIS-derived supermarket proximity and fruit and vegetable serving frequency, using data from 623 English nurseries. Overall, 116 (18%) nurseries served fruits and vegetables infrequently (< 2–3 times/week), but provision differed by supermarket proximity. In adjusted multivariable regression models, nurseries farthest from their nearest supermarket (Q5, 1.7–19.8 km) had 2.38 (95% CI 1.01–5.63) greater odds of infrequent provision. Our results suggest that supermarket access may be important for nurseries in meeting fruit and vegetable provision guidelines. We advance a growing body of international literature, for the first time linking the food practices of institutions to their neighbourhood food retail context.

1. Introduction

By the time UK children enter primary school at age four, over one fifth are already overweight or obese (Lifestyle Statistics Team, 2015). These excess levels of adiposity tend to track into adolescence and adulthood (Singh et al., 2008; Dehghan et al., 2005). The risk of weight gain and obesity can be reduced through healthy eating. In particular, regular fruit and vegetable consumption, especially for those under the age of five, supports healthy growth and development (Gardner et al., 2009; Feinstein et al., 2008; Wiles et al., 2009), and encourages a taste for healthy food in the long term (Carruth et al., 1998). Yet the majority of children aged 2–10 years do not consume the recommended five portions of fruits and vegetables per day (Nelson et al., 2007; Glynn et al., 2005). Thus, there is a need to better understand the determinants of fruit and vegetable consumption *prior* to children entering primary school.

Pre-school nurseries represent an important setting for population-

wide dietary intervention (Osei-Assibey et al., 2016). The number of registered places available in early years childcare in England has been steadily increasing, with 796,500 places available in nurseries in 2013 (Brind et al., 2014). The provision of foods in schools and nurseries is strongly linked to their consumption (van der Horst et al., 2007, French and Stables, 2003, Ball et al., 2008). Healthy nursery practices serve as an opportunity to support parents in encouraging healthy eating at home (Children's Food Trust, 2010a). Further, healthy eating in an educational context such as a nursery can also be especially effective in reducing incidence of 'fussy' eating, as well as issues related to the introduction of novel, healthy foods (Carruth et al., 1998). As children attend nurseries from across the socioeconomic spectrum, establishing healthy eating practices may also help to reduce health inequalities across the lifecourse (Marmot, 2010).

It is important to understand the barriers and enablers to provision of healthy food in this setting. The majority of meals provided in nurseries are prepared in-house, by dedicated cooks and kitchen staff,

* Corresponding author.

E-mail addresses: tb464@medschl.cam.ac.uk (T. Burgoine), john.gallis@duke.edu (J.A. Gallis), tp28@medschl.cam.ac.uk (T. L. Penney), pbm491@medschl.cam.ac.uk (P. Monsivais), sara.neelon@jhu.edu (S.E. Benjamin Neelon).

¹ Contact address: UKCRC Centre for Diet and Activity Research (CEDAR), MRC Epidemiology Unit, University of Cambridge School of Clinical Medicine, Box 285, Institute of Metabolic Science, Cambridge Biomedical Campus, Cambridge CB2 0QQ, UK.

² Present address: Department of Nutrition and Exercise Physiology, Elson S. Floyd College of Medicine, Box 1495, Washington State University, Spokane, WA 99210, USA.

who often source their own ingredients (Children's Food Trust, 2010a). Therefore, access to food stores may be an important contributor to the healthfulness of the foods served. Nurseries report using a range of different types of food outlets for their grocery shopping (Children's Food Trust, 2010b), including wholesalers, convenience stores, specialty food outlets such as butchers and fishmongers, as well as supermarkets (Children's Food Trust, 2010a), which offer a variety of fresh, healthy produce at a range of price points. Nurseries often cite the cost of healthy food as a major barrier to provision (Children's Food Trust, 2010b), with food and drink spending per child per day in English nurseries reported to be as little as £1 (Parker et al., 2011). As a result, access to a supermarket, as a marker of access to a range of affordable, healthy produce, may relate to the provision of healthy foods within nurseries. To our knowledge, no previous studies have linked nursery supermarket access to the types of foods served.

The aim of this study was to examine the association between distance to the nearest supermarket and provision of fruits and vegetables in early years childcare, using data from a large, representative survey of English nurseries.

2. Materials and methods

2.1. Study sample

We used data from the Nutrition in Nurseries study, which surveyed by post a stratified random sample of 2000 nurseries across England in late 2012 and early 2013, with a response rate of 54% (851 nurseries). Nurseries were sampled from a list provided by Ofsted (the regulatory body for early year's childcare in England), which contained details of all organisations providing care for more than two hours per day and for more than six days per year. After-school and sports clubs, as well as childminders, were not eligible for inclusion in the study, nor were nurseries serving less than one snack or meal per day. Further details about the Nutrition in Nurseries study have been published previously (Neelon et al., 2015). All study procedures were approved by the University of Cambridge Psychology Research Ethics Committee.

2.2. Exposure – distance to nearest supermarket

We mapped nursery locations according to their reported postcode using a geographic information system (ArcGIS 10; ESRI, Redlands CA). Postcodes in the UK contain 15 addresses on average, and so allow for relatively precise geocoding (Smith et al., 2013; Burgoine et al., 2014). We sourced the locations of supermarkets belonging to major UK supermarket chains in the form of latitude and longitude coordinates with a stated spatial resolution of within 1 m, from Ordnance Survey (OS) Points of Interest (POI) data in July 2015. Containing data from over 170 suppliers (Ordnance Survey, 2008), OS POI data includes the locations of a wide range of public and private facilities across the UK. For the locations of supermarkets, OS POI data has been validated for use in food environments research against accurate food outlet data from English Local Authorities, demonstrating a 76% positive predictive value and 77% ('good') sensitivity (Burgoine and Harrison, 2013). These values are typical of those reported in validation studies of commercially available business data for food environments research, according to a recent meta-analysis (Lebel et al., 2017). We defined supermarkets as major chain retailers who held a substantial share of the UK grocery market at the time of the study: Tesco, Sainsbury's, ASDA, Morrisons, Waitrose, Aldi, and Co-operative (Kantar Worldpanel, 2016). Using OS MasterMap Integrated Transport Network data and the ArcGIS Network Analyst, we calculated distance from each nursery to the nearest supermarket (km) along the shortest street network route.

2.3. Outcome – frequency of serving fruits and vegetables

In the Nutrition in Nurseries study, managers were asked "how often [their] nursery serves these foods: a) fruits (not including 100% fruit juice); b) vegetables (not chips)". The validity, test-retest reliability and inter-rater reliability associated with responses to these questions in a childcare setting has been previously established and reported (Benjamin et al., 2007). Response options were "never", "less than once per week", "once per week", and "2–3 times per week or more". For analysis here, we dichotomised response frequencies, with infrequent provision defined as serving *both* fruits and vegetables less than 2–3 times per week.

2.4. Covariates

The following variables were reported by nursery responders and considered as potential confounders: number of children enrolled in the nursery (continuous); number of years the nursery has been in operation (years, months); those with primary responsibility for preparing meals (nursery staff member vs non-nursery staff member (includes food service programs of a school or local school authority, a food service company or vendor, parents, others)); nursery manager's highest level of educational attainment (responses grouped as follows: compulsory education - none, GCSEs, NVQs; further education - A levels, 2-year diplomas; higher education - degrees, higher degrees); area-level deprivation (tertiles of index of multiple deprivation (IMD) 2010 scores for English lower super output areas (LSOAs)). Nursery responders indicated that in addition to supermarkets, they also purchased foods from convenience stores, specialist food retailers and wholesalers, proximity to which may serve as potential confounders. Therefore, we used OS POI food outlet location data to calculate street network distance (km) from each nursery to the nearest convenience store (POI use codes: 9470699, 10540737), specialist food retailer (9470662, 9470665, 9470666, 9470667, 9470668, 9470669, 9470670, 9470672, 9470705, 9470819) and wholesaler (9470768), for inclusion as additional covariates.

2.5. Statistical analysis

We used multiple binary logistic regression models to examine associations between distance to the nearest supermarket (quintiles) and odds of serving fruits and vegetables infrequently (both < 2–3 times/week). Model 1 was our unadjusted model. Subsequent adjusted models included the covariates previously described in two groups: Model 2 included the number of children enrolled in the nursery, number of years the nursery had been in operation, those with primary responsibility for preparing meals, nursery manager's highest level of educational attainment, and area-level deprivation; Model 3 additionally adjusted for street network distances to other types of food outlet. This was a complete case analysis, with our sample limited to those with complete data across all variables of interest (n=623). As a sensitivity analysis, we performed multiple imputation utilising all of the Nutrition in Nurseries study data (n=850), with fully conditional specification, with 10 imputations, and which included the outcome and all covariates. As a second sensitivity analysis, we ran an alternative Model 2 specification without adjustment for area-level deprivation, including only the nursery manager's highest level of educational attainment by way of adjustment for SES. Results however were not substantively different from Model 2 as specified and are not presented. Data were analysed using PASW Statistics (SPSS Inc., Chicago IL) and SAS version 9.4 (SAS Institute, Cary NC), with a 2-tailed $P \leq 0.05$ considered statistically significant.

3. Results

Descriptive statistics, overall and stratified by quintiles of distance

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