Preventive Medicine 64 (2014) 103–107

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

A repeated cross-sectional study examining the school impact on child weight status

Andrew James Williams [a,b,1], Katrina Mary Wyatt [a], Craig Anthony Williams [b], Stuart Logan [a], William E. Henley [a,*]

[a] Institute of Health Research, University of Exeter Medical School (formerly Peninsula College of Medicine and Dentistry), Veysey Building, Salmon Pool Lane, Exeter, Devon EX2 4SG, United Kingdom

[b] Children's Health and Exercise Research Centre, Sport and Health Sciences, College of Life and Environmental Sciences, University of Exeter, St. Luke's Campus, Heavitree Road, Exeter, Devon EX1 2LU, United Kingdom

ARTICLE INFO

Available online 13 April 2014

Keywords:
League tables
Obesity
Education
Value-added

ABSTRACT

Objective. The aim of this study is to examine whether there is a differential impact of primary schools upon children's weight status.

Methods. A repeated cross-sectional study was undertaken using five years (2006/07–2010/11) of National Child Measurement Programme data, comprising 57,976 children (aged 4–5 (Reception) and 10–11 (Year 6) years) from 300 primary schools across Devon, England. Examining each year separately, the schools were ranked according to their observed and residual (having accounted for school and neighbourhood clustering and pupil ethnicity and socioeconomic status) school mean body mass index standard deviation score (BMI-SDS). Subtracting the Reception from the Year 6 mean residuals gave 'value-added' scores for each school which were also ranked. The rankings were compared within and across the years to assess consistency.

Results. Although pupil BMI-SDS was high, >97% of the variation in BMI-SDS was attributable to environments other than the school. The 'value-added' by each school was only poorly correlated with the observed and residual pupil BMI-SDS; but none of the rankings were consistent across the five years.

Conclusion. The inconsistency of the rankings and the small variation in BMI-SDS at the level of the school suggests that there is no systematic differential impact of primary schools upon pupil weight status.

Introduction

Non-communicable diseases are now the leading cause of death world-wide (Beaglehole et al., 2011; General Assembly of the United Nations, 2011). Obesity as a risk factor for a number of non-communicable diseases has become a public health priority (Beaglehole et al., 2011). The rising prevalence of obesity, coupled with the realisation that several of the determinants of obesity originate in or before childhood, has led to many preventative efforts being concentrated on children (Butland et al., 2007; Procter, 2007). Moreover, schools, where children congregate to learn, eat, and share activities are readily accessible environments for prevention (Brown and Summerbell, 2009; Khambalia et al., 2012; Procter, 2007; Procter et al., 2008). Within England it has been observed that the prevalence of obesity doubles during the period of primary education (4–11 years of age), leading to questions about whether schools themselves are obesogenic environments (Ridler et al., 2009).

To date, no interventions which sought to affect the school environment or context have been found to have a lasting effect on the prevalence of obesity (Khambalia et al., 2012). Moreover, there is little empirical evidence of any impact of the school environment upon children's weight status (Bonell et al., 2013; Williams et al., 2012, 2013). One of the few papers to examine whether schools had an impact on children's weight status was produced by Procter et al. (2008) who hypothesised:

> '[t]hat by exploring differences between schools, we may be able to determine school factors that are, for better or worse, having an impact on children's risks of obesity. At the same time, we may be able to highlight 'hot' and 'cold' spots of obesity so allowing better targeting of resources to those communities in greatest need.'Procter et al. (2008) p.342.

Abbreviations: BMI-SDS, body mass index standard deviation score; LSOA, lower super output area; NCMP, National Child Measurement Programme.

* Corresponding author. Fax: +44 1392 421009.
E-mail addresses: a.j.williams@exeter.ac.uk (A.J. Williams), k.m.wyatt@exeter.ac.uk (K.M. Wyatt), c.a.williams@exeter.ac.uk (C.A. Williams), stuart.logan@exeter.ac.uk (S. Logan), w.e.henley@exeter.ac.uk (W.E. Henley).
[1] Present address for Andrew James Williams: Scottish Collaboration for Public Health Research and Policy, University of Edinburgh, 20 West Richmond Street, Edinburgh EH8 9DX, United Kingdom.

http://dx.doi.org/10.1016/j.ypmed.2014.04.003

To test this hypothesis Procter et al. (2008) employed a 'value-added' technique similar to those developed in economics and regularly used to assess the educational impact of schools (Amrein-Beardsley, 2008; Rutter, 1979). In education, an individual's value-added score is the change in outcome (e.g. test score) during the period of their schooling. In order to compare school performance the individual scores are aggregated, and it becomes necessary to adjust for differences in school composition which could bias the scores (Amrein-Beardsley, 2008; Rutter, 1979). Procter et al. (2008) accounted for the ethnic and socioeconomic composition of 35 primary schools in Leeds, England, who were participating in the Trends study to rank schools according to their mean observed and expected residual pupil weight status and 'value-added' score. The authors found that there was little similarity between the 'value-added' and expected residual rankings and concluded that this lent credence to the hypothesis that differing school environments have differential impacts upon their pupils (Procter et al., 2008). As a result they suggested that obesity prevention efforts be targeted rather than population wide as 'hot' and 'cold' schools for obesity had been identifiable, and hence future research should focus on such schools. Acknowledging the fallibility of such 'league tables', Procter et al. (2008) also suggested that these analyses should be replicated across a number of years to test the validity of the findings (Goldstein and Spiegelhalter, 1996). This study evaluates and expands upon the technique proposed by Procter et al. (2008) using repeated cross-sectional data from a large routine data source (the National Child Measurement Programme (NCMP)) to examine the potential differential impact of primary schools on children's weight status.

Methods

The English NCMP was introduced in 2005 to monitor progress towards a public service agreement to reduce the prevalence of obese primary school aged children (Dinsdale and Rutter, 2008; South East England Public Health Observatory, 2005). Unless individuals or schools are actively opted out, all Reception (4–5 year olds) and Year 6 (10–11 year olds) pupils in state maintained primary schools have their height and weight measured by a health professional (Dinsdale and Rutter, 2008). Five years of NCMP data (2006/07–2010/11, involving 57,976 pupils) from Devon local authority were used in this study. The child's gender and age at time of measurement collected within the NCMP were used to calculate their body mass index standard deviation score (BMI-SDS) using the United Kingdom 1990 reference population and the LMS method defined by Cole et al. (1995). The child's ethnicity (Department for Education classification), neighbourhood (Lower Super Output Area (LSOA)), school and year group were also recorded (The NHS Information Centre, 2012). Like Procter et al. (2008) we were able to link each child's LSOA to the Index of Multiple Deprivation as a measure of socioeconomic status (Department for Communities and Local Government, 2011). Prior to linking the 2010 Index of Multiple Deprivation to the NCMP data the score was nationally rescaled from 0 to 1 (normalised), to aid interpretation (Goldstein, 2003). The Department for Education ethnicity categories were collapsed into the following five categories to ensure that there were sufficient numbers in each category for analysis; White–British; Any other White background; Chinese, Asian or Asian British; Mixed/Dual background; and Any other ethnic group (including Black or Black British) (Department of Health, 2009). Procter et al. (2008) studied Year 4 (8–9 year olds) rather than Year 6 pupils alongside Reception pupils and used a binary ethnicity classification (south Asian or non-south Asian); otherwise the data sets are similar and both cross-sectional. Consequently, it was possible to apply the method proposed by Procter et al. (2008) within each of the five years of the NCMP data set as outlined below.

Statistical analyses

In education, school-level value-added scores are used as comparable measures of the average improvement in pupil attainment while attending the school. To ensure fair comparisons of different schools, it is important to adjust for differences in school composition. The following steps were taken to apply 'value-added' methods to pupil weight status.

Step 1

Rank schools according to their observed mean BMI-SDS (Observed ranking). Following Procter et al. (2008) both year groups were combined to calculate each school's mean BMI-SDS. The ranking of schools based upon their observed mean BMI-SDS was recorded, giving a rank of the schools with lowest to highest mean pupil weight status. This Observed ranking is not a reflection of school effect on weight status as differences in mean BMI-SDS could relate to differences in school composition (e.g. demographics) or be a reflection of the pre-school (baseline) pupil weight status.

Step 2

Rank schools according to how much their observed mean BMI-SDS differed from the expected ('Expected' ranking). The next step was to adjust the data to determine the extent to which the school's mean pupil weight status differs from that expected. As ethnicity and socioeconomic status are widely recognised determinants of obesity, these were the pupil characteristics used to calculate the expected mean pupil BMI-SDS (Butland et al., 2007). Two-level models, cross-classified by school and neighbourhood (LSOA) in order to account for the fact that children from the same neighbourhood may not attend the same school and vice versa, were used to calculate the expected mean pupil BMI-SDS (Procter et al., 2008). In order to test the need for cross-classification by neighbourhood (LSOA), models with and without neighbourhood cross-classification were tested at this stage. The ranking of schools based upon the extent to which the observed mean BMI-SDS differed from the expected mean BMI-SDS was recorded (Expected residuals). Schools with observed mean pupil weight status which is markedly different from that expected (i.e. high or low residuals) may represent hot and cold spots of obesity.

Step 3

Calculate and rank schools according to a 'value-added' score ('Value-added' ranking)

The 'Expected' ranking gives a measure of the impact of the school, but does not account for pre-school weight status. As the data were cross-sectional, differences within-pupils could not be calculated. Instead, differences between year groups of pupils were calculated through an identical process to that used by Procter et al. (2008). As Reception is the first year of schooling Reception pupils are relatively unexposed to the school environment and context compared with pupils in Year 6, and therefore the Reception pupil weight status was conceptualised as the pre-school weight status. The expected residuals for Reception and Year 6 pupils were calculated separately using the same multilevel model as in Step 2. The difference between these two sets of expected residuals gave a measure (score) of the average 'value-added' to the pupil BMI-SDS by the school, the ranking of which was recorded.

Step 4

Compare the Observed, 'Expected' and 'Value-added' rankings. Primarily Lin's concordance correlation coefficients (ρ_c) (Lin, 1989, 2000; Steichen and Cox, 2002) were used to quantify the agreement between pairs of rankings within each of the five years. Pearson's correlation coefficients (r) were calculated alongside the concordance values, and the rankings were visualised in caterpillar plots; these additional analyses are reposted in the supplementary material.

Step 5

Compare stability of the rankings across the five years (2006/07–2010/11)

Within each ranking, concordance correlation coefficients were calculated comparing the agreement between each of the five years of rankings. As with the previous step Pearson's correlation coefficients and caterpillar plots are reported as supplementary material. Tracking coefficients (kappa) were calculated to explore the extent to which schools maintained approximately the same rankings across the five years. In order to quantify approximate positions, the rankings of schools were split into quintiles each year, prior to the calculation of the tracking coefficients. There was no comparison between the three types of ranking in this step.

The analysis was undertaken in Stata 11 (StataCorp, 2009) with the models estimated using numerical integration with seven quadrature points and restricted maximum likelihood estimation. Due to a sparse matrix in 2010/11 it was necessary to estimate the cross-classified model in R (R Development Core Team, 2011) using `lme4` (Bates et al., 2011) and then transfer the results back into Stata.