

PEDIATRIC ORIGINAL ARTICLE

Maternal employment and early childhood overweight: findings from the UK Millennium Cohort Study

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Background: In most developed countries, maternal employment has increased rapidly. Changing patterns of family life have been suggested to be contributing to the rising prevalence of childhood obesity.

Objectives: Our primary objective was to examine the relationship between maternal and partner employment and overweight in children aged 3 years. Our secondary objective was to investigate factors related to early childhood overweight only among mothers in employment.

Design: Cohort study.

Subjects: A total of 13 113 singleton children aged 3 years in the Millennium Cohort Study, born between 2000 and 2002 in the United Kingdom, who had complete height/weight data and parental employment histories.

Measurements: Parents were interviewed when the child was aged 9 months and 3 years, and the child's height and weight were measured at 3 years. Overweight (including obesity) was defined by the International Obesity Task Force cut-offs.

Results: A total of 23% (3085) of children were overweight at 3 years. Any maternal employment after the child's birth was associated with early childhood overweight (odds ratio (OR) [95% confidence interval (CI)]; 1.14 [1.00, 1.29]), after adjustment for potential confounding and mediating factors. Children were more likely to be overweight for every 10 h a mother worked per week (OR [95% CI]; 1.10 [1.04, 1.17]), after adjustment. An interaction with household income revealed that this relationship was only significant for children from households with an annual income of £33 000 (\$57 750) or higher. There was no evidence for an association between early childhood overweight and whether or for how many hours the partner worked, or with mothers' or partners' duration of employment. These relationships were also evident among mothers in employment. Independent risk factors for early childhood overweight were consistent with the published literature.

Conclusions: Long hours of maternal employment, rather than lack of money may impede young children's access to healthy foods and physical activity. Policies supporting work–life balance may help parents reduce potential barriers.

International Journal of Obesity (2008) **32**, 30–38; doi:10.1038/sj.ijo.0803682; published online 17 July 2007

Keywords: preschool children; employment; mothers; fathers

Introduction

The prevalence of obesity in young children has increased in recent decades.^{1–4} Over the past 10 years in the UK,

overweight (including obesity) has risen from 17 to 22% in boys aged 2–5 years, and from 20 to 25% in girls.³ Concurrently, employment among women has increased, particularly among those with young children.⁵ In 1984, 27% of women with children under age 5 years in the UK were employed;⁶ while in 2004, 59% of married/cohabiting women and 34% of lone parents were employed.⁷ Over this time period, employment among men has remained relatively stable⁵ and employment status does not appear to vary by the age of their youngest child.⁷ Similar trends are evident in countries such as the USA that has data sources tracking childhood overweight and maternal employment since the 1970s.^{2,8} Policies in both countries to reduce child poverty may have resulted in an increase in the number of parents, primarily women with young children, entering the workforce.^{9,10}

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Received 23 January 2007; revised 22 May 2007; accepted 18 June 2007; published online 17 July 2007

Changing patterns of family life associated with single parent households or both parents working have been suggested to be partially responsible for the rising prevalence of overweight in children. Recently, Haslam and James stated, 'Now the environment is deliberately designed to promote inactivity, even children are sedentary, especially when both parents work and they are confined indoors or at school.'¹¹ Furthermore, the Great Britain Parliament House of Commons Health Committee also reported, 'These changing patterns of consumption are in part a response to the far reaching social changes of the last 50 years, including a greater number of women working outside the home, longer working hours, and higher levels of disposable income.'¹² Despite these assertions, there is limited evidence to support or refute the association between maternal employment and childhood overweight.

Studies in school-age children have found that the greater number of hours a mother worked per week increased the likelihood of childhood overweight,^{13,14} but there is no relationship with paternal work patterns.¹⁴ However, there is limited research in preschool children.¹⁵ Our primary objective was to examine the relationship between maternal and partner employment and overweight in a recent, nationally representative cohort of UK children aged 3 years. Our secondary objective was to investigate factors related to early childhood overweight only among mothers who have entered employment since the birth of the cohort child.

Subjects and methods

Subjects and design

The Millennium Cohort Study (MCS) is a UK-wide prospective study of children born in the new millennium. Families were invited to participate if they were eligible for Child Benefit and resident in the UK when their child was aged 9 months old.¹⁶ A stratified cluster sampling framework was employed to adequately represent families from disadvantaged areas and ethnic minority groups. The overall response rate was 72% and additional details on sampling have been reported previously.¹⁷ The original cohort was comprised of 18 819 children (18 553 families) born between September 2000 and January 2002 in England, Wales, Scotland and Northern Ireland. Children who did not permanently emigrate were eligible to participate in the second contact that took place between September 2003 and January 2005.¹⁸ Among the 18 296 singleton infants from the first contact, 14 630 (80%) participated at the second. Refusals were highest in Northern Ireland, in electoral wards in England classified as 'ethnic' (if at least 30% of residents were from an ethnic minority group, based on the 1991 census), and 'disadvantaged' wards from all UK countries (the upper quartile of the Child Poverty Index).¹⁸ Main respondents and their partners were interviewed in the home when the children were mean age 9.7 months (range 8–12) and 37.7

months (range 32–55) and information was collected on a variety of topics relating to the child and their family. Over 99% of the main respondents were natural mothers. Data were obtained from the UK Data Archive, University of Essex. The MCS received ethical approval from the South West and London Multi-Centre Research Ethics Committees.¹⁹

Among the 14 630 singletons, 13 113 had complete and plausible child height/weight data and parental employment histories. Families were excluded if the main respondent was not female (184), the partner respondent was not male (132), there were two children from the same family (10), the main respondent had missing employment data (202), or the child had a missing (802) or implausible (467) height, weight, or body mass index (BMI; weight/height²). Children were less likely to be included in the final sample if their mother was from an ethnic minority group or a lone parent, had lower socioeconomic circumstances, lower household incomes, or a lower academic qualification; however, the overall differences were small.

Outcome measure

At the second contact, trained interviewers weighed the children, without shoes or outdoor clothing, using Tanita HD-305 scales (Tanita UK Ltd., Middlesex, UK), and weights were recorded in kilograms to one decimal place. Heights were measured with the Leicester Height Measure Stadiometer (Seca Ltd., Birmingham, UK) and recorded to the nearest millimetre. The primary outcome measure was childhood overweight (including obesity), which was defined by the International Obesity Task Force cut-offs for BMI.²⁰

Employment variables

Main respondents were asked to provide information about the average hours worked per week, and duration of employment for their current position at each contact as well as any additional periods of employment since the birth of the cohort child. At each contact, partners were asked to provide information about the average hours worked per week, and how long they had been employed at their current position only. A dichotomous employment variable was constructed for mothers and partners. A mother was considered to have been employed if she held any job since the birth of the cohort child. A partner was considered to have been employed if he held a job at one or both contacts.

Based on the methodology of Anderson *et al.*,¹³ two additional independent indicators of employment were constructed for the main and partner respondents: average hours worked per week during the weeks worked and duration of employment. The hours worked per week were calculated by averaging the hours of employment during the weeks worked at the current position at each contact. The duration of employment was calculated by adding together the months worked at the current position at each contact.

Mothers' intensity or duration of employment may have been under- or overestimated, because of a change in employment status between the two contacts. Women who were employed at the first contact and on leave or not employed at the second contact, may have been employed before this period of not working. For these women, their most recent period of employment was included in their estimates (1279). For women who were employed during the entire period between the first and second contacts, and also gave birth (692), 4 months were subtracted from their estimates (average duration of maternity leave). Mothers and partners who had not held any employment had a value of zero for hours worked per week and duration of employment.

For approximately 20% of the sample, partner employment data were missing. There were more missing data for duration of employment (3090) than hours worked (2737), because duration of employment was not collected for partners who were self-employed at the first contact.

Socio-demographic and other risk factors

Demographic and other risk factors were identified that could influence the relationship between parental employment and early childhood overweight. At the first contact, maternal ethnicity was self-reported and classified according to guidelines from the Office for National Statistics,²¹ maternal socioeconomic circumstances were classified according to the National Statistics Socio-economic Classification,²² and maternal education was defined as the highest academic qualification attained. Information was also collected on the age at MCS birth, age at first live birth and lone motherhood status. At the second contact, the number of children in the household was calculated. Household income was reported in bands at both contacts. Household income at the second contact was used; however, if missing, values from the first contact were substituted (1553).

At the first contact, mothers were also asked questions pertaining to their own health and their infant. The mothers' pre-pregnancy body size was determined based on self-reported pre-pregnancy weight and current height. Mothers with a BMI ≥ 25 were considered overweight, including obesity. Mothers were classified as having smoked during pregnancy, if they reported smoking any cigarettes throughout pregnancy. Mothers also reported the baby's birthweight, duration of breastfeeding and the time when the infant was introduced to solid food. At the second contact, mothers provided information on the number of hours the child watched television or videos daily, whether the child had his/her meals at regular times, and who primarily cooked the main meal.

Among mothers in employment, additional information was collected. The type of day care for the child at the second contact was categorised as informal (grandparents, other relatives, friends, neighbours), formal (nanny/au pair, child-minder (registered or unregistered), nurseries or crèche

(workplace, college, local authority or private)) or by the mother/partner.²³ Working atypical hours at the second contact was defined as working every week either in the evening, at night or at weekends. Working atypical hours at the first contact was defined as previously as well as working away from home overnight. At the second contact, main respondents also reported whether they 'do not spend enough time with their child because of work'.

Statistical analysis

All analyses were conducted using STATA statistical software, version 9.2 SE (Stata corporation, College Station, TX, USA), with 'svy' commands to allow for the cluster sampling design and obtain robust standard errors. Weighted percentages, univariate and adjusted analyses were calculated using survey and non-response weights. Univariate logistic regression analyses were conducted to calculate odds ratios (ORs) for each variable with respect to childhood overweight and Wald tests were used to obtain *P*-values. Victora *et al.*²⁴ recommend using a hierarchical framework to determine potential confounding and mediating factors. Factors potentially confounding the relationship between maternal employment and early childhood overweight were likely to have occurred before mothers took up employment, while potential mediators were likely to be on the causal pathway between maternal employment and early childhood overweight. The following were considered potential confounding factors: maternal ethnic group, socioeconomic circumstances, household income, highest academic qualification, age at first live birth, age at MCS birth, lone motherhood status, number of children in the household, maternal pre-pregnancy body size, smoking during pregnancy and birthweight. The following were considered potential mediating factors: breastfeeding duration, introduction of solid food, television viewing, whether child has meals at regular times and who primarily cooks the main meals. Additional potential mediating factors were relevant for mothers who were employed: type of day care, working atypical hours at first or second contacts, whether they reported they 'do not spend enough time with child because of work'. Potential confounding, mediating and employment-related factors significant at the $P \leq 0.1$ level were included in the adjusted models in a stepped approach. Analyses were separately adjusted for potential confounding and mediating factors in order to assess the effects of each; analyses among employed mothers were also subsequently adjusted for employment-related factors.

In total, four sets of logistic regression analyses were conducted. The first set examined the relationship between a dichotomous measure of maternal and partner employment and childhood overweight. The second examined the relationship between maternal and partner intensity and duration of employment and childhood overweight. This analysis was repeated for mothers in employment only. The third analysis was conducted for mothers in employment

only, with an interaction between maternal hours worked per week and type of day care. In the fourth analysis, based on the findings by Anderson *et al.*,¹³ the regression models were re-run with an interaction between maternal hours worked per week and household income.

When an outcome is relatively common, ORs often overestimate the relative risk.²⁵ Therefore, analyses were repeated using modified Poisson regression²⁶ that estimates rate ratios as a measure of relative risks. The findings were similar, but the rate ratios tended to be closer to 1 than the ORs by 2–10% (data not shown).

Results

At age 3 years, 23% (3085) of children were overweight or obese. Approximately 89% (11253) of the mothers were white, 31% (3754) were in managerial or professional occupations, 35% (4598) were in semi-routine and routine occupations, and 14% (1966) were lone mothers. The mean age of the mothers at the birth of the cohort child was 29 years (range 13–48) and the partners' age was 32 years (range 15–68). Since the cohort child's birth, 41% (5484) of mothers and 3% (389) of partners had not worked. The mothers who were employed (7629) worked a median of 22 h per week (interquartile range, 16–31 h) and for 27 months (interquartile range, 13–32 months) since the birth of the cohort child. The partners who were employed (9987) worked a median of 40 h per week (interquartile range, 38–48 h) and for 28 months (interquartile range, 13–36 months).

Table 1 presents the potential confounding and mediating factors that were independently associated with early childhood overweight. Among all mothers these were the following: maternal ethnicity, lower academic qualifications, age at first live birth, lone motherhood, overweight pre-pregnancy, smoking during pregnancy, birthweight, never breastfeeding, breastfeeding for less than 4 months, introduction of solid food before 4 months, watching television at least for a hour daily, and both parents cooking the main meal. Among mothers in employment, children were more likely to be overweight if they were cared for by informal day care arrangements, and the mother reported that she 'did not spend enough time with her child because of work'.

There was limited evidence for an association between early childhood overweight and any employment after the child's birth for mothers or partners in univariate analyses (Table 2). However, the relationship strengthened after adjustment for potential confounding factors and attenuated slightly after adjustment for potential mediating factors. Children were also more likely to be overweight for every 10 h their mother worked per week. The relationship strengthened after adjustment for potential confounding factors, and was maintained after adjustment for potential mediating factors. There was no evidence for an association between early childhood overweight and hours the partner worked or with mothers' or partners' duration of employment.

The model was re-run including an interaction between maternal hours worked per week and household income. For every 10 h a mother worked, children from households with an annual income of £22 000 (\$38 500) or higher were more likely to be overweight than children from the lowest-income group in univariate analyses (Table 3). After adjustment, the relationship was maintained for children from families with an annual income of £33 000 (\$57 750) or higher.

Mothers in employment

Among the 7629 mothers who were employed, 24% (1851) of their children were overweight. Approximately 93% (6999) of the mothers were white, 40% (2949) were in managerial or professional occupations, 29% (2210) were in semi-routine and routine occupations and 9% (699) were lone mothers.

Children were also more likely to be overweight for every 10 h their mother worked per week. The relationship strengthened after adjustment for potential confounding factors, and was maintained after adjustment for potential mediating and employment-related factors (Table 2). There was no evidence for an association between partners' hours worked or mothers' or partners' duration of employment and early childhood overweight. An interaction between maternal hours worked per week and type of day care revealed that for every 10 h a mother worked, children in formal day care arrangements were more likely to be overweight than children cared for by their mother/partner in univariate analyses (1.25 [1.12, 1.38]); this relationship was maintained after adjustment for potential confounding, mediating and employment-related factors (1.24 [1.09, 1.40]). There was no difference in early childhood overweight between children cared for by informal arrangements, and those cared for by their mother/partner in univariate (1.04 [0.95, 1.14]) or adjusted analyses (1.02 [0.92, 1.13]).

The model was re-run including an interaction between maternal hours worked per week and household income. For every 10 h a mother worked, children from households with an annual income of £33 000 (\$57 750) or higher were more likely to be overweight than children from the lowest income group in univariate analyses (Table 3). The relationship attenuated slightly after adjustment.

Discussion

We found that children were more likely to be overweight at age 3 years if their mother held any employment since their birth. Specifically, children's likelihood of being overweight increased with the number of hours their mother worked per week; however, this relationship was only significant for children from families with the highest household income levels. We found no evidence for a relationship between

Table 1 Weighted percentages and univariate ORs (95% CIs) for overweight in children aged 3 years

| All mothers (n = 13 113) | n | Overweight (weighted %) | Univariate OR (95% CI) |
|--|--------|-------------------------|------------------------|
| <i>Potential confounding factors</i> | | | |
| <i>Maternal ethnic group</i> | | | |
| White | 11 253 | 23.3 | 1 |
| Mixed | 111 | 26.6 | 1.19 (0.76, 1.87) |
| Indian | 347 | 11.9 | 0.44 (0.31, 0.63) |
| Pakistani or Bangladeshi | 784 | 19.1 | 0.78 (0.66, 0.92) |
| Black Caribbean or Black African | 389 | 30.2 | 1.42 (1.09, 1.87) |
| Other ethnic group | 209 | 21.7 | 0.92 (0.58, 1.45) |
| <i>Maternal socioeconomic circumstances</i> | | | |
| Managerial and professional occupations | 3754 | 23.2 | 0.94 (0.83, 1.06) |
| Small employers and own account workers | 470 | 19.3 | 0.75 (0.58, 0.96) |
| Intermediate occupations | 2290 | 21.3 | 0.84 (0.73, 0.97) |
| Lower supervisory and technical occupations | 720 | 23.1 | 0.94 (0.76, 1.16) |
| Semi-routine and routine occupations | 4598 | 24.3 | 1 |
| Never worked and long-term unemployed | 1141 | 22.6 | 0.91 (0.75, 1.10) |
| <i>Household income</i> | | | |
| £0–11 000 per annum | 3040 | 23.9 | 1 |
| £11 000–22 000 per annum | 3845 | 24.0 | 1.00 (0.88, 1.14) |
| £22 000–33 000 per annum | 2777 | 23.8 | 0.99 (0.87, 1.14) |
| £33 000+ per annum | 3152 | 21.1 | 0.85 (0.73, 0.99) |
| <i>Highest academic qualification</i> | | | |
| GCSE grades A–C or higher | 9548 | 22.3 | 1 |
| GCSE grades D–G or lower | 3553 | 25.1 | 1.17 (1.04, 1.31) |
| Age at first live birth, per 5-year increase | 12 751 | | 0.96 (0.92, 1.00) |
| Age at MCS birth, per 5-year increase | 13 104 | | 1.00 (0.96, 1.04) |
| <i>Lone motherhood status</i> | | | |
| Non-lone mother | 11 147 | 22.6 | 1 |
| Lone mother | 1966 | 26.1 | 1.21 (1.06, 1.39) |
| <i>Number of children in the household</i> | | | |
| 1 | 3269 | 22.7 | 1 |
| 2 or 3 | 8488 | 23.0 | 1.02 (0.91, 1.14) |
| 4 or more | 1356 | 24.5 | 1.10 (0.93, 1.30) |
| <i>Maternal pre-pregnancy body size</i> | | | |
| Normal weight | 8718 | 19.7 | 1 |
| Overweight | 3634 | 31.1 | 1.84 (1.66, 2.03) |
| <i>Smoked during pregnancy</i> | | | |
| No | 8573 | 22.2 | 1 |
| Yes | 4494 | 24.5 | 1.14 (1.03, 1.25) |
| Birthweight (kg) | 13 093 | | 1.83 (1.66, 2.01) |
| <i>Potential mediating factors</i> | | | |
| <i>Breastfeeding duration</i> | | | |
| ≥4 months | 3436 | 20.4 | 1 |
| Never breastfed | 4178 | 25.5 | 1.34 (1.18, 1.52) |
| <4 months | 5491 | 23.2 | 1.18 (1.05, 1.33) |
| <i>Introduction of solid food</i> | | | |
| ≥4 months | 8501 | 21.6 | 1 |
| <4 months | 4609 | 25.7 | 1.26 (1.14, 1.38) |

Table 1 (continued)

| All mothers (n = 13 113) | n | Overweight (weighted %) | Univariate OR (95% CI) |
|--|------|-------------------------|------------------------|
| <i>Television viewing daily</i> | | | |
| Less than 1 h | 3046 | 21.1 | 1 |
| 1–2 h | 7724 | 23.4 | 1.14 (1.03, 1.28) |
| More than 3 h | 2342 | 24.8 | 1.23 (1.06, 1.44) |
| <i>Whether child has meals at regular times</i> | | | |
| Always | 6240 | 22.7 | 1 |
| Usually | 5651 | 23.6 | 1.05 (0.96, 1.16) |
| Sometimes or never | 1221 | 22.2 | 0.97 (0.82, 1.15) |
| <i>Who primarily cooks the main meal</i> | | | |
| Main respondent | 6856 | 22.6 | 1 |
| Partner | 822 | 21.3 | 0.93 (0.76, 1.13) |
| Both share responsibility | 2154 | 24.6 | 1.12 (0.99, 1.26) |
| <i>Mothers in employment (n = 7629)</i> | | | |
| <i>Type of day care</i> | | | |
| Main/partner | 1738 | 22.9 | 1 |
| Informal | 2972 | 25.4 | 1.15 (0.99, 1.33) |
| Formal | 2272 | 22.5 | 0.98 (0.84, 1.14) |
| <i>Working atypical hours weekly—first contact</i> | | | |
| No | 3617 | 24.1 | 1 |
| Yes | 2512 | 23.7 | 0.98 (0.85, 1.13) |
| <i>Working atypical hours weekly—second contact</i> | | | |
| No | 3915 | 23.7 | 1 |
| Yes | 2868 | 23.1 | 0.97 (0.85, 1.10) |
| <i>Do not spend enough time with child because of work</i> | | | |
| No | 7122 | 23.2 | 1 |
| Yes | 498 | 28.6 | 1.33 (1.06, 1.65) |

Abbreviations: CI, confidence interval; MCS, Millennium Cohort Study; OR, odds ratio. Missing number of cases for all mothers: maternal ethnic group (20), socioeconomic circumstances (140), household income (299), highest academic qualification (12), age at first live birth (362), age at MCS birth (9), main pre-pregnancy body size (761), smoked during pregnancy (46), birthweight (20), breastfeeding duration (8), introduction of solid food (3), television viewing (1), whether child has meals at regular times (1) and who primarily cooks the main meal (3281). Missing number of cases for mothers in employment: type of day care (647), working atypical hours weekly—first contact (1500), working atypical hours weekly—second contact (846) and do not spend enough time with child because of work (9).

partner hours worked or maternal or partner duration of employment and early childhood overweight. The effects were evident after adjustment for both potential confounding and mediating factors. These relationships were also apparent among mothers in employment. Independent risk factors for early childhood overweight were consistent with the published literature.

The breadth of data on parental employment and other risk factors for early childhood overweight in the MCS afforded us the opportunity to examine this relationship among a contemporary, nationally representative cohort of UK preschool children. In studies of older children, one examined intensity and duration of employment among mothers only,¹³ while the other examined intensity of employment only among mothers and partners.¹⁴ We were

Table 2 Univariate and adjusted odds ratios (OR) (95% confidence intervals (CI)) for parental employment and overweight in children aged 3 years

| All mothers (n = 13 113) | Univariate OR (95% CI) | Adjusted OR ^a (95% CI) | Adjusted OR ^{a,b} (95% CI) | |
|------------------------------------|------------------------|-------------------------------------|---------------------------------------|---|
| <i>Maternal employment</i> | | | | |
| None | 1 | 1 | 1 | |
| Any since the child's birth | 1.07 (0.97, 1.18) | 1.15 (1.02, 1.29) | 1.14 (1.00, 1.29) | |
| <i>Partner employment</i> | | | | |
| None | 1 | 1 | 1 | |
| Any since the child's birth | 0.99 (0.74, 1.32) | 0.90 (0.64, 1.26) | 0.94 (0.65, 1.36) | |
| | Univariate OR (95% CI) | Adjusted OR ^{a,c} (95% CI) | Adjusted OR ^{a,b,c} (95% CI) | |
| <i>Maternal employment</i> | | | | |
| Hours worked per week, per 10 h | 1.06 (1.02, 1.09) | 1.12 (1.06, 1.18) | 1.10 (1.04, 1.17) | |
| Duration of employment, per 1 year | 1.03 (0.99, 1.07) | 0.97 (0.91, 1.04) | 0.99 (0.92, 1.06) | |
| <i>Partner employment</i> | | | | |
| Hours worked per week, per 10 h | 0.99 (0.95, 1.04) | 0.99 (0.94, 1.04) | 0.99 (0.94, 1.05) | |
| Duration of employment, per 1 year | 1.01 (0.97, 1.06) | 1.00 (0.95, 1.05) | 0.98 (0.92, 1.04) | |
| Mothers in employment (n = 7629) | Univariate OR (95% CI) | Adjusted OR ^{a,c} (95% CI) | Adjusted OR ^{a,b,c} (95% CI) | Adjusted OR ^{a,b,c,d} (95% CI) |
| <i>Maternal employment</i> | | | | |
| Hours worked per week, per 10 h | 1.11 (1.05, 1.17) | 1.15 (1.08, 1.22) | 1.13 (1.06, 1.20) | 1.14 (1.06, 1.22) |
| Duration of employment, per 1 year | 1.01 (0.94, 1.09) | 1.00 (0.92, 1.10) | 1.02 (0.92, 1.12) | 1.00 (0.90, 1.11) |
| <i>Partner employment</i> | | | | |
| Hours worked per week, per 10 h | 1.00 (0.94, 1.06) | 1.01 (0.95, 1.07) | 1.01 (0.95, 1.08) | 1.02 (0.95, 1.09) |
| Duration of employment, per 1 year | 1.01 (0.95, 1.07) | 1.00 (0.94, 1.06) | 0.98 (0.91, 1.05) | 0.99 (0.92, 1.06) |

Abbreviations: CI, confidence interval; OR, odds ratio. ^aAdjusted for potential confounding factors (maternal ethnic group, highest academic qualification, age at first live birth, lone motherhood status, maternal pre-pregnancy body size, smoked during pregnancy and birthweight). ^bAdjusted for potential mediating factors (breastfeeding duration, introduction of solid foods, television viewing daily and who primarily cooks the main meal). ^cAdjusted for employment (maternal hours worked and duration, partner hours worked and duration). ^dAdjusted for employment-related risk factors (type of day care, 'do not spend enough time with child because of work').

able to combine the methodologies of both studies because of the extensive employment data that were collected. Furthermore, interviewers measured the height and weight of the children, which removed any potential biases related to parent-reported height and weight.

Although the study sample is slightly more advantaged than the MCS families from the second contact, the results are still broadly generalizable to the UK population. Complete employment histories could not be constructed for each parent, so proxy measures were developed. These calculations could potentially under- or overestimate parents' intensity or duration of employment; however, these situations were considered and modified accordingly. Although there is the potential for residual confounding, risk factors were included from previous studies^{13,14} as well as additional risk factors for overweight in preschool children, such as pre-pregnancy body size, smoking during pregnancy and television viewing.¹⁵

Our findings are consistent with two nationally representative studies of school-age children from the US and Canada, which found that the greater number of hours a mother worked per week increased the likelihood of childhood overweight.^{13,14} The effect sizes in the present study are slightly greater than those in the previous studies. Since adjusting for background characteristics strengthened the

relationship between maternal employment and early childhood overweight, our results might be attributed to the inclusion of potential confounding and mediating factors in our analysis that were not available in the previous studies. The strength of the effect sizes might also suggest that the intensity of mother's employment is particularly important for an onset of overweight during the preschool years as compared to onset in later childhood. However, Anderson *et al.*¹³ also stratified their analysis by age and found no relationship among preschool-age children. A recent review identified two studies in preschool children, which reported a direct relationship between overweight and a dichotomous measure of maternal employment in univariate analyses only.¹⁵ In contrast, we found that this association gained significance after adjustment for potential confounding factors.

Similar to Phipps *et al.*¹⁴ we found that partner employment was not associated with childhood overweight. In the MCS, only 3% of partners did not engage in any employment since the child's birth and approximately 92% worked at least 31 h per week. The lack of variability may partially explain the difficulty in exploring this relationship. However, employment among men has remained stable in recent years, while employment among women, especially those with young children, has increased.⁵

Table 3 Univariate and adjusted ORs (95% CIs) for overweight in children aged 3 years, with interaction between maternal hours worked per week and household income

| All mothers (n = 12 814) | Univariate OR (95% CI) | Adjusted OR ^a (95% CI) |
|---|---------------------------|--------------------------------------|
| <i>Household income</i> | | |
| <i>£0–11 000 per annum</i> | | |
| Hours worked per week, per 10 h | 1 | 1 |
| <i>£11 000–22 000 per annum</i> | | |
| Hours worked per week, per 10 h | 1.03 (0.97, 1.10) | 1.09 (0.99, 1.20) |
| <i>£22 000–33 000 per annum</i> | | |
| Hours worked per week, per 10 h | 1.08 (1.00, 1.17) | 1.10 (0.99, 1.21) |
| <i>£33 000+ per annum</i> | | |
| Hours worked per week, per 10 h | 1.16 (1.09, 1.24) | 1.15 (1.07, 1.24) |
| <i>Mothers in employment (n = 7497)</i> | | |
| <i>Household income</i> | | |
| <i>£0–11 000 per annum</i> | | |
| Hours worked per week, per 10 h | 1 | 1 |
| <i>£11 000–22 000 per annum</i> | | |
| Hours worked per week, per 10 h | 1.06 (0.95, 1.19) | 1.08 (0.93, 1.25) |
| <i>£22 000–33 000 per annum</i> | | |
| Hours worked per week, per 10 h | 1.07 (0.97, 1.19) | 1.13 (0.98, 1.30) |
| <i>£33 000+ per annum</i> | | |
| Hours worked per week, per 10 h | 1.22 (1.12, 1.33) | 1.19 (1.07, 1.33) |

Abbreviations: CI, confidence interval; OR, odds ratio. ^aAdjusted for employment (maternal hours worked and duration, partner hours worked and duration), potential confounding factors (maternal ethnic group, highest academic qualification, age at first live birth, lone motherhood status, maternal pre-pregnancy body size, smoked during pregnancy and birth-weight) and potential mediating factors (breastfeeding duration, introduction of solid food, television viewing daily and who primarily cooks the main meal).

^bAdjusted for employment-related risk factors (type of day care, 'do not spend enough time with child because of work').

Our results and those by Anderson *et al.*¹³ found that maternal work intensity was associated with childhood overweight only among families in the highest income groups. These findings suggest that long hours of maternal employment rather than lack of money may impede young children's access to healthy foods and physical activity. For example, parental time constraints could increase a child's consumption of snack foods and/or increase television use. However, few studies have examined the impact of maternal employment on determinants of overweight in children of any age and there is even less evidence in preschool populations. Johnson *et al.*²⁷ found that many preschool children in the US did not meet dietary requirements in the late 1980s, but there was no difference in the quality of their diet by maternal employment status. In school-age children, those whose mothers were employed, were less likely to have 'less healthy eating' than children whose mothers were

full-time homemakers.²⁸ Certain and Kahn²⁹ reported no difference in television viewing among children aged 0–11 or 24–35 months by maternal employment status, but children aged 12–23 months were more likely to watch television daily for at least 2 h, if their mother was not employed.

Among mothers who were employed, there was also evidence that the intensity of a mother's employment was a risk factor for early childhood overweight, specifically among children from families in the highest income group. We found that children were more likely to be overweight if the mother reported that she 'did not spend enough time with her child because of work'. We can only speculate that these children may have had greater access to convenience foods and/or fewer opportunities for physical activity. Although there was some evidence in univariate analyses that children cared for by informal arrangements were more likely to be overweight than children cared for by their parents, an interaction between maternal hours worked and type of day care revealed that children in formal arrangements may be at higher risk for overweight if their mother worked more hours. While only a few studies have examined the impact of day care on overweight in young children, they define day care differently. For example, a study of German preschool children found no association between the type of kindergarten and overweight,³⁰ however, this study compared how long the child stayed with the provider, rather than type of care provider. As these authors suggest, categories of provider may not represent the diet or physical activity available to the children.

We also identified independent risk factors for overweight, which are consistent with the published literature. Reviews have found that maternal overweight pre-pregnancy,¹⁵ smoking during pregnancy,^{15,31} birthweight^{31,32} and television viewing¹⁵ are associated with overweight, while breastfeeding is a protective factor.¹⁵ We also found that children who were introduced to solid food before 4 months were more likely to be overweight at age 3 years; however, reviews have reported inconsistent evidence for this relationship.^{15,32}

While rates of maternal employment have increased in recent decades, there have also been changes in children's and women's health-related behaviours. Children's consumption of snack food³³ and sweetened beverages³⁴ has increased substantially. Current estimates suggest that preschool children from the UK also watch television for approximately 19 h weekly.³⁵ Furthermore, there is evidence that overweight among women early in pregnancy has increased over the past decade.³⁶ In addition, breastfeeding has been found to be protective against overweight in our study and others;^{15,31} however, rates remain lower³⁷ than the World Health Organization recommendation.³⁸ Returning to work soon after a child's birth is also a barrier to women initiating and continuing breastfeeding.^{39,40}

Although we found that maternal employment is associated with overweight among British preschool children, our results and the larger evidence base suggest there are

many risk factors for overweight. Recent reviews have concluded that prevention is a necessary component to curbing the rise in childhood obesity.^{15,31} However, policies and interventions should address not only individual factors but also the contextual environment of children including the family, community, society and government. Our findings on maternal employment and other risk factors should be considered within this framework. Further research is needed to examine factors along the causal pathway between maternal employment patterns and childhood overweight, which can help inform policy and interventions. For example, little is known about differences in children's diet or physical activity levels by maternal employment status. It will be important for future studies to obtain this information, so these factors can be controlled for in analyses. If they confound the relationship between maternal employment and childhood overweight, then 'maternal employment' may actually be a proxy for the changing patterns of health-related behaviours as a result of time constraints, due to modern society. However, policies supporting parents, particularly women, to enter the workforce^{9,10} suggest that current levels of maternal employment are likely to be maintained or increase in the future. UK policies promoting work-life balance⁴¹ may help protect parents' time to provide opportunities for their children to access healthy foods and physical activity.

Acknowledgements

We would like to thank all of the Millennium Cohort Study families for their cooperation, and the Millennium Cohort Study team at the Centre for Longitudinal Studies, Institute of Education, University of London. The Millennium Cohort Study is funded by grants to Professor Heather Joshi, Director of the study from the ESRC and a consortium of government funders. There was no funding source for this study. Summer Sherburne Hawkins is funded by a Department of Health Researcher Development Award. Research at the Institute of Child Health and Great Ormond Street Hospital for Children NHS Trust benefits from R&D funding received from the NHS Executive.

Ethical approval

The Millennium Cohort Study was approved by the South West and London Multi Centre Research Ethics Committees. The present analyses did not require additional ethics approval.

Details of contributors

SSH and CL contributed to the conception, study design, interpretation of the data and first draft of the article. SSH also contributed to the analysis. TJC contributed to the analysis and interpretation of the data, and further drafting of the article. All authors have also seen and approved the final version. All authors have no conflicts of interest to declare. SSH will act as guarantor for the paper.

References

- 1 Stamatakis E, Primatesta P, Chinn S, Rona R, Falaschetti E. Overweight and obesity trends from 1974 to 2003 in English children: what is the role of socio-economic factors? *Arch Dis Child* 2005; **90**: 999–1004.
- 2 Ogden CL, Troiano RP, Briefel RR, Kuczmarski RJ, Flegal KM, Johnson CL. Prevalence of overweight among preschool children in the United States, 1971 through 1994. *Pediatrics* 1997; **99**: e1.
- 3 Stamatakis E. Anthropometric measurements, overweight, and obesity. In: Sproston K, Primatesta P (eds). *Health Survey for England 2002: The Health of Children and Young People, vol. 1*. The Stationery Office: London, 2002.
- 4 Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999–2004. *JAMA* 2006; **295**: 1549–1555.
- 5 Duffield M. Trends in female employment. *Labour Market Trends, November*. Office of National Statistics: London, 2002.
- 6 Central Statistics Office. *Social Trends 21*. Central Statistics Office: London, 1991.
- 7 Walling A. *Families and work: Labour Market Trends, July*. Office for National Statistics: London, 2005.
- 8 US Bureau of Labor Statistics. *Women in the Labor Force: a Databook*. US Department of Labor: Washington, DC, 2005.
- 9 Her Majesty Revenue & Customs. *Child Tax Credit and Working Tax Credit*. Her Majesty Revenue & Customs: London, 2005.
- 10 The White House. *Welfare Reform* <http://www.whitehouse.gov/infocus/welfarereform> (accessed 21 March 2006).
- 11 Haslam DW, James WPT. Obesity. *Lancet* 2005; **366**: 1197–1209.
- 12 Great Britain Parliament House of Commons Health Committee. *Obesity, Third Report of Session 2003–04, vol. 1*. The Stationery Office: London, 2004.
- 13 Anderson PM, Butcher KF, Levine PB. Maternal employment and overweight children. *J Health Econ* 2003; **112**: 477–504.
- 14 Phipps SA, Lethbridge L, Burton P. Long-run consequences of parental paid work hours for child overweight status in Canada. *Soc Sci Med* 2006; **62**: 977–986.
- 15 Hawkins SS, Law C. A review of risk factors for overweight in preschool children: a policy perspective. *Int J Pediatr Obes* 2006; **1**: 195–209.
- 16 Dex S, Joshi H (eds) *Babies of the New Millennium*. Policy Press: London, 2005.
- 17 Plewis I. *Millennium Cohort Study: Technical Report on Sampling*. Institute of Education, University of London: London, 2004.
- 18 Plewis I, Ketende S. *Millennium Cohort Study: Technical Report on Response, 1st edn.* Institute of Education, University of London: London, 2006.
- 19 Hansen K. *Millennium Cohort Study First and Second Surveys: A Guide to the Datasets* 1st edn. Institute of Education, University of London: London, 2006.
- 20 Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000; **320**: 1–6.
- 21 Office for National Statistics. *Ethnic Group Statistics: a Guide for the Collection and Classification of Ethnicity Data*. The Stationery Office: London, 2003.
- 22 Rose D, Pevalin D. *A Researcher's Guide to the National Statistics Socio-economic Classification*. Sage Publications: London, 2003.
- 23 Brewer M, Shaw J. *Childcare Use and Mothers' Employment: a Review of British Data Sources*. Department for Work and Pensions: London, 2004.
- 24 Victora CG, Huttly SR, Fuchs SC, Olinto MTA. The role of conceptual frameworks in epidemiological analysis: a hierarchical approach. *Int J Epidemiol* 1997; **26**: 224–227.
- 25 McNutt L-A, Wu C, Xue X, Hafner JP. Estimating the relative risk in cohort studies and clinical trials of common outcomes. *Am J Epidemiol* 2003; **157**: 940–943.
- 26 Zou G. A modified poisson regression approach to prospective studies with binary data. *Am J Epidemiol* 2004; **159**: 702–706.

- 27 Johnson RK, Smiciklas-Wright H, Crouter AC, Willits FK. Maternal employment and the quality of young children's diets: empirical evidence based on the 1987–1988 food consumption survey. *Pediatrics* 1992; **90**: 245–249.
- 28 Sweeting H, West P. Dietary habits and children's family lives. *J Hum Nutr Diet* 2005; **18**: 93–97.
- 29 Certain LK, Kahn RS. Prevalence, correlates, and trajectory of television viewing among infants and toddlers. *Pediatrics* 2002; **109**: 634–642.
- 30 Rapp K, Schick KH, Weiland SK. Type of kindergarten and other potential determinants of overweight in pre-school children. *Public Health Nutr* 2005; **8**: 642–649.
- 31 Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. *Obes Rev Suppl* 2004; **5/1**: 4–85.
- 32 Parsons TJ, Power C, Logan S, Summerbell CD. Childhood predictors of adult obesity: a systematic review. *Int J Obes Suppl* 1999; **23/8**: S1–S107.
- 33 Jahns L, Siega-Riz AM, Popkin BM. The increasing prevalence of snacking among US children from 1977–1996. *J Pediatr* 2001; **138**: 493–498.
- 34 Nielsen SJ, Popkin BM. Changes in beverage intake between 1977 and 2001. *Am J Prev Med* 2004; **27**: 205–210.
- 35 Office of Communications. *Child Obesity—Food Advertising in Context*. Office of Communications: London, 2004.
- 36 Kanagalingam MG, Forouhi NG, Greer IA, Sattar N. Changes in booking body mass index over a decade: retrospective analysis from a Glasgow Maternity Hospital. *BJOG* 2005; **112**: 1431–1433.
- 37 World Health Organization. *The WHO Global Data Bank on Breastfeeding and Complementary Feeding*, <http://www.who.int/research/iycf/bfcb/bfcf.asp?menu=00> (accessed 23 January 2006).
- 38 World Health Organization, Unicef. *Global Strategy for Infant and Young Child Feeding*. World Health Organization: Geneva, 2002.
- 39 Hawkins SS, Griffiths LJ, Dezateux C, Law C, The Millennium Cohort Study Child Health Group. Maternal employment and breastfeeding initiation: findings from the Millennium Cohort Study. *Paediatr Perinat Epidemiol* 2007; **21**: 242–247.
- 40 Hawkins SS, Griffiths LJ, Dezateux C, Law C, The Millennium Cohort Study Child Health Group. The impact of maternal employment on breastfeeding duration in the UK Millennium Cohort Study. *Public Health Nutr* doi:10.1017/s13689800072226096.
- 41 Department for Trade and Industry. *Flexible working: the Right to Request and the Duty to Consider*. Department for Trade and Industry: London, 2003.