**Duration of sleep at 3 years of age is associated with fat and fat-free mass at 4 years of age: the Southampton Women’s Survey**

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**Contributors statement**

Janis Baird conceptualized and designed the study, drafted the initial manuscript, and approved the final manuscript as submitted.

Catherine Hill and Nicholas Harvey: Drs Hill and Harvey contributed to the design of the study and to statistical analyses, reviewed and revised the manuscript, and approved the final manuscript as submitted.

Sarah Crozier: Dr Crozier undertook some of the statistical analyses required when revising the manuscript and commented on and approved the revised version.

Sian Robinson, Keith Godfrey and Cyrus Cooper: Professors Robinson, Godfrey and Cooper led the Southampton Women’s Survey, reviewed and revised the manuscript, and approved the final manuscript as submitted.

Hazel Inskip led the Southampton Women’s Survey, conceptualized and designed the study, carried out the statistical analyses, and approved the final manuscript as submitted.

**Summary**

Many studies have shown that shorter sleep duration in childhood is associated with higher body mass index and proposed that it is due to an effect of sleep on adiposity. There is little evidence about the association of sleep with fat-free mass. This study examined the association between child’s sleep duration at age 3 years and fat and fat-free mass at 4 years of age in a prospective cohort study of 302boys and 285 girls. Study participants were taking part in the Southampton Women’s Survey, a longitudinal study of mothers and children from preconception onwards.

Total sleep duration at age 3 years was derived from parental report of night sleep and nap duration. Body composition was assessed by DXA at 4 years. Mean total sleep duration was 11.5 hours. In linear regression analyses, adjusted for potentially confounding factors (maternal educational attainment, pre-pregnancy BMI, smoking during pregnancy, child’s gestational age at birth, age at DXA, sex, age last breastfed, dietary quality at 3 years, TV watching and hours actively on the move and parental social class) shorter sleep in hours was associated with higher BMI (kg/m2) (β=-0.2340, 95% CI -0.373, -0.096), a greater fat mass index (kg) (β=-0.1182 (-0.218, -0.018)) and a greater fat-free mass index (kg) (β=-0.100 (-0.185 ,-0.015)).

Previous research suggested that the association between shorter sleep and higher body mass index is due to an effect on adiposity. Our findings are novel suggesting that the relationship between sleep and BMI is also determined by an effect on muscle.

**Keywords**

Sleep

Child

Body composition

Fat mass

Fat-free mass

**Introduction**

Three recent systematic reviews have confirmed that shorter sleep duration is associated with higher body mass index (BMI) at a range of ages from two to 18 years.1-3 Meta-analyses conducted within these reviews suggest that shorter sleep duration in pre-pubertal children, defined as less than 10 hours per night, is associated with a raised odds ratio for obesity (BMI >95th centile) of around 1.6.1-3

Researchers have speculated that the relationship between sleep duration and BMI is due to increased adiposity. However, BMI is not a direct measure of adiposity as it incorporates both lean and fat mass. To explore the potential association between sleep and adiposity, a number of studies have assessed the relationship between duration of sleep and skinfold thicknesses, as a measure of body fat. Two such studies assessed the relationship between sleep duration and skinfold thickness at seven years of age in cross sectional analyses and showed that shorter sleep duration predicted higher skinfold thickness .4,5 Likewise, in a study of 915 children aged three years participating in Project Viva, sleep of less than 12 hours duration was associated with higher sum of subscapular and triceps skinfold thickness,6 and a study of more than 7000 German children aged between three andten years demonstrated an inverse association between sleep duration and body fat based on skinfold thickness measurement in cross sectional analyses at all of the ages studied.7 These findings appeared to confirm that the association between sleep and BMI was determined by an effect on adiposity.

BMI is not a direct measure of adiposity as it incorporates both fat and fat-free mass and recent studies have used Dual –energy X-ray Asorptiometry to assess body composition and measure fat-free mass. None, however, have demonstrated a significant association between sleep and fat-free mass. In the FLAME study of 244 children aged three to seven years living in Dunedin, New Zealand, sleep was assessed, using sleep logs and accelerometry, at both three and seven years of age and body composition by DXA at seven years of age.8 Shorter sleep duration was associated with fat mass index but associations between shorter sleep and differences in fat free mass index were non-significant, findings that were consistent with the view that the association between shorter sleep and BMI was due to increased adiposity. More recently, a second study of the Project Viva cohort, demonstrated that persistent shorter sleep duration from six months to seven years of age was associated with higher total and trunk fat determined by DXA at seven years of age, but did not report whether there was an association between sleep and fat-free mass or not.9

We have explored the association between sleep duration and detailed measures of body composition, collected at four years of age using DXA, in children participating in the Southampton Women’s Survey. Specifically, we aimed to examine how parental report of child’s sleep at three years of age predicted both fat- and fat-free mass at four years of age.

**Materials and methods**

The SWS is a population-based study that characterised 12,583 non-pregnant women aged 20-34 years resident in the city of Southampton, UK, between 1998 and 2002. Women who subsequently became pregnant were followed up and a range of outcomes for the 3,158 children born to these women was assessed at regular intervals throughout childhood. A description of the cohort and study methodology has been published elsewhere.10

When children were three years of age, their mothers were asked to report the usual times their child fell asleep at night and woke in the morning, from which the duration of night sleep was derived. Mothers also reported the frequency and duration of any day-time naps. Total 24-hour sleep duration, in hours and minutes, was derived by adding the duration of day-time naps to night time sleep. Mothers also reported how much time, on average, each day their children spent watching television and were actively on the move. They completed a Strengths and Difficulties Questionnaire (SDQ) describing their child’s behaviour, indicating whether children had hyperactivity, conduct or emotional problems.11 At earlier phases of SWS follow up, mothers had reported their highest level of educational attainment, occupation and partner’s occupation, whether and how much they smoked during pregnancy, and how they fed their child during infancy and childhood including the date they last breastfed. At 4 years of age, a sub-set of 900 children attended for an assessment of body composition by DXA, using a Hologic Discovery instrument (Hologic Inc., Bedford, MA, USA). Fat and fat-free mass were derived from a whole body scan, using paediatric software. The total radiation dose for each scan was 4.7 microsieverts (paediatric scan mode). Children’s height and weight, at the time of DXA, were measured according to standard protocols using a portable stadiometer (Leicester height measurer) and digital Seca scale respectively.

Linear regression was used to relate the body composition measures (fat mass index and fat-free mass index) to total duration of sleep. Fat mass index was derived by dividing fat mass at DXA by height squared. Fat-free mass was derived by adding lean and bone mass and then dividing the sum of these measures by height squared. Major potentially confounding factors were identified a priori as age at DXA measurement, gestational age at birth and sex of the child and we adjusted for these in initial regression analyses. In fully adjusted models we included the additional potentially confounding factors of, maternal pre-pregnant body mass index, maternal educational attainment and smoking during pregnancy, parental socio-economic status, age last breastfed, child’s television watching and level of activity (hours actively on the move within a 24-hour period) and dietary quality (a prudent diet score at 3 years of age12). The diet score is a z-score measured in SD units and thus a score of zero is the mean. We used maternal pre-pregnancy body mass index as our measure of maternal body composition in the absence of any maternal measures of body mass index following pregnancy.

In order to assess which component of body composition (fat or fat-free mass) was most strongly related to sleep duration, we carried out analyses mutually adjusting each index for the other.

The SWS received ethical approval from Southampton and South West Hampshire Local Research Ethics Committee.

**Results**

Participants in the study were 587 children, participating in the SWS, who underwent DXA at 4 years of age, had full sleep data at age 3 years and complete information on all potential confounding variables. The mean age of participants was 4.1 years; 302 were boys and 285 girls (table 1). The girls had higher fat mass and lower fat-free mass indices than the boys. The girls also had higher prudent diet scores indicating that their diets were healthier than those of the boys. The mean duration of total sleep in a 24 hour period was 11.4 hours for the boys and 11.5 hours for the girls. Boys were perceived to be more actively on the move than girls but there were no significant differences between them in average nap time or in time spent watching TV. According to SDQ criteria, around 10% of boys and 7% of girls were classified as hyperactive.

In analyses adjusted for gestational age, age at DXA and sex, sleep had a statistically significant inverse association with BMI such that children who slept for a shorter period at three years had higher BMI at four years (table 2) . In a model adjusting for all potentially confounding factors, the association remained highly significant (β=-0.234kg/m2/hr, 95%CI: -0.373,- 0.096, P=0.001) (table 3).

Shorter sleep duration was significantly associated with higher fat mass index in the model adjusted for gestational age, age at DXA and sex (table 2) and the association was little changed in the fully adjusted model (β=-0.118kg/m2 per hr, 95%CI: -0.218,- 0.018, P=0.042) (table 3).

Shorter sleep duration was also significantly associated with higher fat-free mass index in the minimally adjusted model and adjusting for all of the potentially confounding factors considered did not change the magnitude of the association (β=-0.100kg/m2 per hr, 95%CI: -0.185,- 0.015, P=0.02) .

We repeated analyses for fat and fat-free mass indices in relation to sleep, by including adjustment for the other index in the regression as well as for the potentiallyconfounding factors. Both associations remained similar (β for fat mass index = -0.108 kg/m2/hr, 95% CI -0.205, -0.008, P=0.03 and for fat-free mass index β=-0.092 kg/m2/hr, 95% CI -0.177, -0.007, P=0.03).

Further analyses (data not shown), to consider possible mediators in the relationship between sleep and body composition, showed that neither hours actively on the move or hyperactivity, whether considered separately or together, altered the relationship between sleep and lean mass. The relationship between sleep and fat mass was strengthened slightly by adjustment for these factors.

**Discussion**

In this population-based study we found that shorter sleep duration at three years of age was strongly associated with higher BMI at 4 years of age. In sex- and age-adjusted analyses, shorter sleep duration was associated with higher fat mass and fat-free mass indices. After adjustment for important confounding factors, shorter sleep duration was significantly associated with higher fat and fat free mass indices. After mutual adjustment of the fat and fat-free mass indices for each other, both remained significantly inversely associated with sleep.

Many studies have demonstrated the inverse association between sleep duration and BMI at ages from early childhood to adolescence. 1-3 However, to our knowledge, only two studies have assessed the relationship of sleep duration with detailed measures of body composition obtained using DXA. The first of these, the FLAME study of 244 children aged three to seven years, found a significant association between sleep and fat mass but the relationship with fat-free mass was non-significant. .8 In the present study, the association between sleep duration and fat-free mass indexwas statistically significant, unlike the FLAME study, but our effect size also fell within the confidence intervals of the FLAME study effect size. The associations between sleep duration and fat mass were more than four times greater in FLAME than in the present study. One possible explanation for these differences might be that the more objective accelerometry measures of sleep used in the FLAME more accurately reflect sleep duration than our measure which relied on parental report. In addition to the differences in our measures of sleep another potential explanation for the difference in sleep/fat-free mass findings is that the FLAME study of 244 children may potentially have lacked the power to demonstrate a significant relationship between sleep duration and fat-free mass The second study, a recently published account of the relationship of sleep between the ages of six months and seven years with body composition at seven years among 1046 children taking part in Project Viva showed that shorter sleep duration was associated with total and trunk fat mass indices (also determined by DXA similar to both FLAME and the present study). 9 However, as the associations of sleep with fat-free mass index or other fat-free measures were not reported in the paper, the findings cannot be compared with those of the present study.

Our study had a number of strengths. It was a population-based longitudinal study of a large sample of children whose mean sleep duration was consistent with published reference values for their age group.13 Extensive data collection associated with the aims of the cohort study allowed adjustment for a range of important social, maternal and childhood factors that potentially confound the relationship between sleep duration and body composition. We used DXA to take detailed measurements of body composition allowing fat and fat-free mass to be assessed. Sleep duration was treated as a continuous variable, rather than creating categories of sleep duration as has been the case in much of the published literature. Our study was observational and so the relationships identified cannot indicate causality.

A weakness of our study was the fact that our measure of sleep duration was based on maternal report rather than on an objective measurement of sleep duration. Parental report of sleep is not as good a measure of sleep as use of accelerometry or other objective measuring devices, and will induce measurement error. This, however, is more likely to weaken rather than strengthen findings, though if the error contributes to bias this will not be true. However, it is not obvious that parents would under-report sleep in children with higher BMI or over-report it in those with lower BMI particularly in the present study .where the data were collected during an interview covering a wide range of childhood factors and, at the time, the major focus of the study was on nutrition and growth and not on sleep. As such, mothers were unlikely to consider the significance of sleep duration for their child’s health and wellbeing. Another potential weakness of the study is the lack of longitudinal data on sleep duration. There is some evidence to suggest that sleep patterns are relatively stable during early childhood: a longitudinal cohort study of 1492 children suggested that parents report a stable sleep pattern in the majority of children between two and six years of age.14 However, studies employing more objective measures of sleep have suggested instability of sleep patterns. A recent study of longitudinal sleep patterns in the FLAME cohort using axial accelerometry for a minimum of 4 days a year between the ages of 3 and 7 years suggested instability of sleep duration over this time frame in 185 children.15. We also lacked longitudinal data on body composition since DXA was not performed at three years of age. Nevertheless, the fact that the exposure, sleep, preceded that body composition outcomes by a year makes the associations we identified more plausible from a biological perspective since the effects of sleep on body composition are unlikely to be immediate.16

While published studies suggest that the association of sleep duration with body mass index is due to an effect of sleep on adiposity, our findings indicate that the association of sleep with fat-free mass is also important. Shorter sleep duration was associated with significantly higher fat and fat-free mass indices in analyses adjusted for important confounding factors. It is well established that body composition tends to change in the transition from infancy into childhood, with an “adiposity rebound” towards greater fat mass at 3 to 4 years.17 Lean mass tends to increase as fat mass increases, due to the greater mechanical demands of a heavier body; there is no evidence, as far as we are aware, that sleep duration relates directly to the timing or magnitude of the adiposity rebound. Indeed, in further mutually adjusted analyses of fat and fat-free mass indices, the associations with sleep duration remained statistically significant, suggesting that the association between sleep duration and fat-free mass is not simply due to associations with fat mass. These relationships also proved robust to further adjustment for childhood behaviour, a factor that could potentially mediate an association between sleep and body composition.

Others have considered the possibility of a relationship between sleep and lean mass although none have studied it directly. Börnhorst and colleagues have speculated that increased waking hours would be associated with increased activity and higher food intakes leading to increased levels of both fat and muscle.18 Consistent with this hypothesis, we found that there was a significant inverse correlation between sleep duration and activity levels. However, the association of shorter sleep with greater fat-free mass index remained significant and was little changed even after adjusting for activity levels. Likewise, although a number of studies have demonstrated a relationship between shorter sleep in early childhood and increased levels of hyperactivity and other behavioural problems,19,20 the association between sleep and fat-free mass index in the present study was independent of childhood behaviour. Another potential explanation for the association between sleep duration and fat-free mass relates to developmental maturity. Children with more advanced developmental maturity might have higher fat and lean mass but also shorter sleep duration, mirroring the characteristics of children in mid-childhood.

Our findings provide a challenge to current thinking on the relationship between sleep duration and body composition. Most previous research has suggested that the relationship between shorter sleep and higher BMI is a result of an effect of sleep on adiposity mediated by diet. Our findings, however, suggest that shorter sleep duration is also associated with higher fat-free mass, an effect that is independent of the effect of sleep on fat mass. The mechanisms for the association between sleep and fat-free mass are unclear though maturation might play a part. In our study the association was not explained by children’s levels of physical activity. However, our measure of physical activity was limited and so exploration of this potential mechanism using more objective measures of physical activity is needed. As this is, to our knowledge, the first study to report the association between shorter sleep duration and higher fat-free mass, these findings will need to be replicated in further populations and settings. They do, however, suggest that the association between sleep duration and body mass index is related not only to an effect on adiposity but also to an effect on other components of body composition

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**Table 1: Baseline characteristics of children who received a DXA at age 4yrs (restricted to the 587 children with complete data on all information in Table 3)**

|  | **Boys (n=302)** | **Girls (n=285)** |  |
| --- | --- | --- | --- |
|  | **Summary statistic** | **Summary statistic** | **P-value** |
| Age (y) (mean(SD)) | 4.1 (0.1) | 4.1 (0.1) | 0.1 |
| Height (cm) (mean(SD)) | 104.6 (3.6) | 104.2 (4.2) | 0.3 |
| Weight from scales (kg) (mean(SD)) | 17.8 (2.0) | 17.8 (2.4) | 0.9 |
| BMI (kg/m2) (mean(SD)) | 16.2 (1.3) | 16.4 (1.5) | 0.3 |
| Fat mass index (kg/m2) (mean(SD)) | 4.1 (0.9) | 4.9 (1.1) | <0.001 |
| Fat-free mass index (kg/m2) (mean(SD)) | 11.7 (0.8) | 10.9 (0.8) | <0.001 |
| Gestational age (weeks) (mean(SD)) | 39.8 (1.6) | 39.9 (1.8) | 0.6 |
| Age last breastfed (weeks) (median(IQR)) | 13 (2-32) | 13 (1-27) | 0.6 |
| Mother's height (cm) (mean(SD)) | 163.4 (6.2) | 164.2 (6.5) | 0.1 |
| Mother’s pre-pregnancy body mass index (kg/m2) (median(IQR)) | 24.4 (22.5-27.1) | 24.0 (22.2-27.7) | 0.9 |
| Hours watching TV per day at 3y (median(IQR)) | 1.5 (1.5-2.5) | 1.5 (1.5-2.5) | 0.7 |
| Hours sleeping per 24h at 3y (mean(SD)) | 11.4 (0.7) | 11.5 (0.9) | 0.3 |
| Hours sleeping per night at 3y (mean(SD)) | 11.1 (0.7) | 11.2 (0.9) | 0.1 |
| Average nap time (hours) per day (median(IQR)) | 0.14 (0.00-0.57) | 0.00 (0.00-0.43) | 0.2 |
| Hours actively on the move per day at 3y (median(IQR)) | 2.0 (1.5-3.2) | 2.0 (1.0-3.0) | 0.002 |
| Prudent diet score at 3y (mean(SD)) | 0.0 (0.9) | 0.2 (0.9) | 0.04 |
| Hyperactivity classified as definite (n(%)) |  |  | 0.1 |
| Yes | 32 (10.6) |  |  |
| Mother’s educational qualification level (n(%)) |  |  | 0.6 |
| None | 5 (1.7) | 2 (0.7) |  |
| CSE/GCSE D-G | 25 (8.3) | 24 (8.4) |  |
| O levels/GCSE A\*-C | 80 (26.5) | 72 (25.3) |  |
| A levels | 90 (29.8) | 90 (31.6) |  |
| HND | 23 (7.6) | 24 (8.4) |  |
| Degree | 79 (26.2) | 73 (25.6) |  |
| Highest social class of parents (n(%)) |  |  | 0.9 |
| Professional (I) | 36 (11.9) | 34 (11.9) |  |
| Management and technical (II) | 158 (52.3) | 147 (51.6) |  |
| Skilled non-manual (IIIN) | 73 (24.2) | 73 (25.6) |  |
| Skilled manual (IIIM) | 24 (7.9) | 19 (6.7) |  |
| Partly skilled (IV) | 10 (3.3) | 12 (4.2) |  |
| Unskilled (V) | 1 (0.3) | 0 (0.0) |  |
| Mother smoked in pregnancy (n(%)) |  |  | 0.7 |
| Yes | 39 (12.9) | 34 (11.9) |  |

*\*All body composition measures were taken at 4 years of age unless otherwise stated*

**Table 2: Multiple regression analyses of BMI, fat mass index and fat-free mass index in relation to sleep duration and major potential confounders (data restricted to the 587 children who had complete values for all potential confounders considered in Table 3).**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| BMI | Regression coefficient (β) | 95% confidence interval | | P-value |
| Sleep duration (hrs) | -0.225 | -0.367 | -0.083 | 0.002 |
| Gestational age (weeks) | 0.036 | -0.031 | 0.103 | 0.3 |
| Child's sex (Male = 0 Female = 1) | 0.121 | -0.104 | 0.345 | 0.3 |
| Child's age at DXA (yrs) | -1.559 | -3.274 | 0.155 | 0.08 |
|  |  |  |  |  |
| Fat mass index (kg/m2) |  |  |  |  |
| Sleep duration (hrs) | -0.112 | -0.215 | -0.009 | 0.03 |
| Gestational age (weeks) | 0.034 | -0.015 | 0.082 | 0.2 |
| Child's sex (Male = 0 Female = 1) | 0.818 | 0.655 | 0.981 | <0.001 |
| Child's age at DXA (yrs) | -0.556 | -1.803 | 0.690 | 0.4 |
|  |  |  |  |  |
| Fat-free mass index (kg/m2) |  |  |  |  |
| Sleep duration (hrs) | -0.100 | -0.184 | -0.015 | 0.02 |
| Gestational age (weeks) | -0.005 | -0.045 | 0.035 | 0.8 |
| Child's sex (Male = 0 Female = 1) | -0.764 | -0.898 | -0.630 | <0.001 |
| Child's age at DXA (yrs) | -0.510 | -1.533 | 0.513 | 0.3 |

**Table 3: Multiple regression analyses of BMI, fat mass index and fat-free mass index in relation to sleep duration and potential confounders (analyses restricted to the 587 children with complete data)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BMI (kg/m2)** | **Regression coefficient (β)** | **95%CI** | | **P-value** |
| Sleep duration (hrs) | -0.234 | -0.373 | -0.096 | 0.001 |
| Gestational age (weeks) | 0.043 | -0.022 | 0.108 | 0.2 |
| Child's sex (Male = 0 Female = 1) | 0.101 | -0.118 | 0.320 | 0.4 |
| Child's age at DXA (yrs) | -1.687 | -3.343 | -0.030 | 0.05 |
| Mother's preconception BMI (Kg/m2) | 0.057 | 0.032 | 0.082 | 0 |
| Mother smoked during pregnancy | 0.744 | 0.401 | 1.087 | 0 |
| Mother's educational attainment (6 categories low to high) | 0.007 | -0.095 | 0.110 | 0.9 |
| Highest social class of parents (6 categories high to low) | 0.006 | -0.129 | 0.140 | 0.9 |
| Age child was last breastfed (completed months) | -0.009 | -0.032 | 0.014 | 0.4 |
| Child's hours watching TV per day at age 3 years | -0.012 | -0.126 | 0.102 | 0.8 |
| Child's prudent diet score (SD) at age 3 years | -0.097 | -0.230 | 0.036 | 0.2 |
| Child’s hours spent actively on the move at age 3 years | -0.069 | -0.147 | 0.010 | 0.09 |
| **Fat mass index (kg/m2)** |  |  |  |  |
| Sleep duration (hrs) | -0.118 | -0.218 | -0.018 | 0.02 |
| Gestational age (weeks) | 0.042 | -0.005 | 0.089 | 0.08 |
| Child's sex (Male = 0 Female = 1) | 0.803 | 0.645 | 0.961 | 0 |
| Child's age at DXA (yrs) | -0.707 | -1.905 | 0.491 | 0.25 |
| Mother's preconception BMI (Kg/m2) | 0.037 | 0.019 | 0.055 | 0 |
| Mother smoked during pregnancy | 0.445 | 0.197 | 0.693 | 0 |
| Mother's educational attainment (6 categories low to high) | 0.000 | -0.074 | 0.074 | 0.99 |
| Highest social class of parents (6 categories high to low) | 0.021 | -0.076 | 0.119 | 0.7 |
| Age child was last breastfed (completed months) | -0.016 | -0.033 | 0.001 | 0.06 |
| Child's hours watching TV per day at age 3 years | 0.011 | -0.072 | 0.094 | 0.8 |
| Child's prudent diet score (SD) at age 3 years | -0.106 | -0.202 | -0.010 | 0.03 |
| Child’s hours spent actively on the move at age 3 years | -0.063 | -0.120 | -0.006 | 0.03 |
|  |  |  |  |  |
| **Fat-free mass index (kg/m2)** |  |  |  |  |
| Sleep duration (hrs) | -0.100 | -0.185 | -0.015 | 0.02 |
| Gestational age (weeks) | -0.005 | -0.045 | 0.034 | 0.8 |
| Child's sex (Male = 0 Female = 1) | -0.758 | -0.893 | -0.624 | 0 |
| Child's age at DXA (yrs) | -0.469 | -1.485 | 0.546 | 0.4 |
| Mother's preconception BMI (Kg/m2) | 0.018 | 0.002 | 0.033 | 0.03 |
| Mother smoked during pregnancy | 0.333 | 0.122 | 0.543 | 0.002 |
| Mother's educational attainment (6 categories low to high) | -0.006 | -0.069 | 0.056 | 0.8 |
| Highest social class of parents (6 categories high to low) | -0.040 | -0.123 | 0.042 | 0.3 |
| Age child was last breastfed (completed months) | 0.017 | 0.003 | 0.032 | 0.02 |
| Child's hours watching TV per day at age 3 years | -0.030 | -0.100 | 0.040 | 0.4 |
| Child's prudent diet score (SD) at age 3 years | -0.021 | -0.102 | 0.061 | 0.6 |