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Child care before age 6 and body mass index at age 7 years in a cohort of Danish Children

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Abstract

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SEBN conceived of the study, oversaw the analysis, and drafted the manuscript. CSM, MKJ, EO, MWG, and TIAS helped conceptualize the analysis, contributed to the drafting of the manuscript, and had final approval of the submitted and published versions. CSM, MKJ, and TIAS also provided access to and critical interpretation of the data. JAG carried out and contributed to the design of the analysis and had final approval of the submitted and published versions.

Conflict of Interest Statement:

The authors do not have any competing financial interests or conflicts of interest in relation to the work described.

Previous studies show inconsistent associations between child care and obesity. We examined 24 714 children in the Danish National Birth Cohort who were also in the Childcare Database. We conducted multivariable linear regressions examining child care prior to age 6, overall and by type (daycare, crèche, age-integrated, and kindergarten), and BMI z-score at 7 years, stratifying on maternal socio-occupational status. A total of 19 760 (80.0%) children attended child care before age 6. Child care prior to age 6 was associated with BMI z-score at 7 years (0.004 units; 95% CI: 0.001, 0.008; $p=0.01$). Care in a kindergarten was the only type of care associated with BMI (0.009 units; 95% CI: 0.003, 0.02; $p=0.01$). For children of higher socio-occupational status mothers, child care was associated with a 0.008 unit increase in BMI (95% CI: 0.004, 0.01; $p<0.001$). Child care had little impact on BMI in this sample of Danish children.

Keywords

Child Care; Obesity; Danish National Birth Cohort; Childcare Database; Denmark

Introduction

Child care attendance has been associated with obesity in children in Canada, China, Denmark, Finland, the United Kingdom (UK), and the United States (US).^{1–12} The association may depend on the age of children in care—prior studies of infants have linked early care with obesity.^{1, 2, 5, 12} We found that child care in infancy was associated with an increased risk of obesity at 12 months in a cohort of Danish children,¹ but is unclear if this relationship continues as children age. Prior studies also explored differential effects of care based on family socioeconomic status, maternal education, and household income, reporting conflicting results.^{9, 10, 13, 14} Child care may promote the development of obesity if the care setting is of lower quality and more of an obesogenic environment than the family home. This may be especially true for children from higher socioeconomic status families. Here, we examine child care in the first 6 years and body mass index (BMI) at age 7. We hypothesized that, consistent with our previous findings, child care through age 6 would be associated with higher BMI z-score at 7 years, and that children of higher socio-occupational status mothers and higher income families would be most affected.

Materials and Methods

We obtained child care data from the Childcare Database, a national record of attendance throughout Denmark from 1999 through 2004 for all children up to 6 years of age.¹⁵ We computed number of months in child care from birth to 6 years, overall and by 4 types of care: daycare home, crèche, age-integrated facility, and kindergarten. Children in Denmark typically attend daycare homes (programs with less than 5 children of similar ages), crèches (programs with approximately 30–40 children of varying ages), or age-integrated facilities (programs with up to 70 children of varying ages) in their first few years of life.¹⁵ At around 3 years of age, more than half of children in child care are moved from a crèche or age-integrated facility to a kindergarten—those who stay in a crèche or age-integrated facility transition to a kindergarten-like program within their current care arrangement.¹⁵ Kindergarten is a type of child care for children ages 3–6 years in Denmark and is not the

equivalent of kindergarten in the US, which is the start of primary school. Instead, kindergartens in Denmark are more like formal preschools or pre-K programs in the US. In the Childcare Database, kindergartens had an average of 56.3 children in care and 7.9 teachers.¹⁵

We obtained covariate and outcome data from the Danish National Birth Cohort (DNBC), a cohort of 100 418 pregnant women enrolled between 1996 and 2002 representing nearly 30% of all deliveries in Denmark during that time.¹⁶ During the DNBC 7-year interview, mothers reported their children's height (centimeters) and weight (kilograms) obtained from the most recent visit with a physician or public health nurse or from parent measurement at home. We calculated age- and sex-specific BMI *z*-scores using World Health Organization reference data. Mothers reported pre-pregnancy height and weight at the DNBC 16-week gestation interview and age at birth, occupational status, breastfeeding duration, education, and gross annual household income at the 18-month post-partum interview. We used maternal occupation and education to categorize them as low, medium, or high socio-occupational status, consistent with previous DNBC studies.^{17, 18} We obtained child birth data (date, weight, length) from the Medical Birth Register of Denmark.

For the primary analysis, we examined the total number of months in any child care from birth to 6 years, overall (any versus none) and by each of 4 types of care and BMI *z*-score at age 7. Children could spend time in more than one type of care, so we examined each of the three types in a combined linear regression model. We report estimates per an additional 6 months of care. Secondly, we explored stratification by socio-occupational status (low/medium compared to high) and family income (lower/higher median split). In multivariable models, we included covariates that were of *a priori* interest, including child sex, age, and birth weight for gestational age *z*-score, breastfeeding duration, maternal pre-pregnancy BMI, age at child's birth, socio-occupational status, and family income. Because of the high percentage of missing data with covariates, we performed multiple imputation using fully conditional specification using the outcome and covariates in the imputation model.¹⁹ We conducted analyses using SAS version 9.4 (SAS Institute, Cary, North Carolina, US).

Results

A total of 19 760 (80.0% of the 24 714) children attended child care in their first 6 years (Table 1). Of those, children spent a mean (SD, lower-upper quartile) of 36.9 (18.0, 21.7–51.6) months in care – 8.9 (11.8, 0.0–20.2) in a daycare home, 5.7 (9.9, 0.0–9.3) in a crèche, 13.6 (18.2, 0.0–25.9) in an age-integrated facility, and 7.9 (12.0, 0.0–15.1) in a kindergarten. After adjustment and imputation, child care through age 6 was associated with BMI *z*-score at 7 years (0.004 units; 95% CI: 0.001, 0.008; *p*=0.01) (Table 2). Care in a kindergarten was the only type associated with BMI *z*-score at 7 years (0.009 units; 95% CI: 0.003, 0.02; *p*=0.01). The interaction between child care and maternal socio-occupational status was significant (*p*=0.02), but not child care and household income (*p*=0.13). Therefore, we present stratified models for socio-occupational status only. For children of higher socio-occupational status mothers, child care was associated with a 0.008 unit increase in BMI *z*-score (95% CI: 0.004, 0.01; *p*<0.001) and care in a kindergarten was associated with a 0.02 unit increase in BMI *z*-score (95% CI: 0.006, 0.02; *p*=0.001) (Table 2).

Discussion

Child care was associated with later BMI, especially for children of higher socio-occupational status mothers. However, effect sizes were minimal and likely not clinically significant. These findings are somewhat consistent with previous studies of formal child care and obesity in the UK and the US.^{4, 10} However, contrary to our findings, previous studies also found that the less formal types of care were most associated with obesity.^{2, 3, 5, 10} Instead we found that care in a kindergarten, which is a formal type of preschool children attend before they enter primary school in Denmark, was associated with BMI. But, the magnitude of the effect was small. More formal child care with higher teacher-child ratios may contribute to the development of obesity if children receive less individual attention during mealtimes and are allowed to be more sedentary.²⁰

Previous studies suggest that family socioeconomic status, maternal education, and household income may influence the relationship between child care and obesity, but these have yielded conflicting results.^{9, 10, 13, 14} One found no association with obesity among a sample of lower socioeconomic status children and a second found a reduced risk of obesity for children in child care with mothers with less education—both were studies of US children.^{13, 14} Conversely, a third found that child care was associated with higher BMI for girls only from low-income families in Canadian children.⁹ In a fourth study in the UK, child care was associated with obesity for children of higher socioeconomic status families only.¹⁰ Results of our study indicate that child care was minimally associated with higher BMI z-scores for children of high socio-occupational status mothers. Conversely, we did not observe a relationship between child care and later BMI for children of low/medium socio-occupational status mothers and lower income families. The child care environment may be more stressful and less healthy than the family home, especially for children from higher resource families, thereby contributing to the development of obesity. A recent study found that children spent more time being sedentary in child care than at home.²⁰ These previous studies have yielded mixed results; findings from a forthcoming systematic review will help clarify these relationships.²¹

This study has several limitations. We were not able to assess potentially important intermediate variables that might fall within the causal pathway between child care and BMI, such as dietary intake, physical activity, sleep, and stress.^{22–24} Additionally, the Childcare Database did not include hours of care or whether the care was full or part time. We assumed children were in care for a full day and that time in care was the same for all types of care. Children in this study were also nearly all white, with very limited ethnic diversity in the cohort. Finally, we relied on parent measurement for the 7-year BMI outcome for approximately one third of the sample. A recent study demonstrated the validity of these data in a sub-sample of DNBC children.²⁵ A number of prior studies have also successfully applied the DNBC 7-year BMI data as a main outcome.^{26–28} Additionally, a study of Belgian children ages 3–7 years found that parent measurement of child height and weight was more accurate than parent estimation.²⁹

In this large sample of Danish children, child care prior to age 6 was weakly associated with later BMI. This relationship was more pronounced, however, in children from higher socio-

occupational status mothers and children in kindergarten care. While these findings may be reassuring to many parents, future studies should further explore differential effects for children from higher resource families. Intervention studies may be challenging to implement but could resolve confusion about the association between child care and obesity.

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What is already known about this subject

- Child care attendance has been associated with obesity in children in studies in Canada, China, Denmark, Finland, the United Kingdom, and the United States.
- The relationship between child care and obesity may depend on the age of care onset and the type of child care attended.
- Previous studies have explored differential effects of care based on family socioeconomic status, maternal education, and household income, yielding conflicting results.

What this study adds

- Our prior work demonstrated that child care in infancy was associated with higher weight in a cohort of Danish children—we extend this work and examine child care through 6 years and body mass index (BMI) at age 7.
- Child care was associated with later BMI, especially for children of higher socio-occupational status mothers, but effect sizes were small.
- Care in a kindergarten was the only type of child care associated with BMI but results are likely not clinically significant.

Table 1

Demographic characteristics of children and mothers in the Danish National Birth Cohort who were also in the Childcare Database (n=24 714)

	Any Child Care (n=19 760)		No Child Care (n=4 954)	
Child Characteristics	Mean	SD	Mean	SD
Birth weight, grams	3 592.0	559.1	3 592.4	561.8
Gestational age at birth, weeks	40.0	1.7	40.0	1.8
Birth weight for gestational age z-score	0.17	1.0	0.19	1.0
Child care attendance, months	36.9	18.0	--	--
Daycare home	8.9	11.8	--	--
Crèche	5.7	9.9	--	--
Age-integrated facility	13.6	18.2	--	--
Kindergarten	7.9	12.0		
Age entered child care, months	13.4	10.0	--	--
Body mass index z-score at 7 years	0.004	1.0	0.06	1.1
Child age at 7-year assessment, years	7.1	0.3	7.0	0.3
	Number	Percent	Number	Percent
Sex, female	9 669	48.9	2 410	48.6
Breastfeeding duration, weeks				
0–13	4 192	26.7	1 272	31.7
14–21	6 663	42.4	1 602	39.9
22	4 855	30.9	1 144	28.5
Body mass index category at 7 years				
Underweight, <5 th percentile	1 000	5.1	259	5.2
Normal weight, 5–84 th percentile	16 014	81.0	3 918	79.1
Overweight, 85–94 th percentile	1 754	8.9	445	9.0
Obese, 95 th percentile	992	5.0	332	6.7
Mother Characteristics	Mean	SD	Mean	SD
Age at child's birth, years	30.6	4.2	30.3	4.3
Pre-pregnancy body mass index, kg/m ²	23.0	3.8	24.0	4.7
Family income in Danish Kroner, in 1000's	541.5	424.1	490.3	178.0
	Number	Percent	Number	Percent
Maternal socio-occupational status				
Low	1 271	6.7	481	10.1
Medium	6 058	32.0	1 943	40.8
High	11 590	61.3	2 341	49.1

Table 2

Estimates and 95% confidence intervals (CI) for associations of child care from birth to 6 years, per increment of 6 months of care, with body mass index (BMI) z-score at 7 years, overall and stratified by maternal socio-occupational status

Child Care	BMI Z-score		
Overall Sample	Adjusted imputed ^a		
	Estimate	95% CI	P-value
Any child care	0.004	0.001, 0.008	0.01
Daycare home	−0.0004	−0.007, 0.006	0.91
Crèche	−0.001	−0.009, 0.007	0.77
Age-integrated	0.002	−0.002, 0.007	0.33
Kindergarten	0.009	0.003, 0.02	0.01
Low /Medium Socio-Occupational Status			
Any child care	0.0004	−0.006, 0.006	0.89
Daycare home	−0.009	−0.02, 0.002	0.10
Crèche	0.002	−0.01, 0.02	0.79
Age-integrated	0.001	−0.007, 0.009	0.76
Kindergarten	0.004	−0.007, 0.01	0.50
High Socio-Occupational Status			
Any child care	0.008	0.004, 0.01	<0.001
Daycare home	0.006	−0.003, 0.02	0.18
Crèche	−0.0004	−0.01, 0.01	0.94
Age-integrated	0.003	−0.003, 0.008	0.37
Kindergarten	0.02	0.006, 0.02	0.001

^a Adjusted for child sex, child age, child birth weight for gestational age z-score, breastfeeding duration, maternal pre-pregnancy BMI, maternal age at conception, maternal socio-occupational status (overall sample analysis only), and family income.