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Early child care and obesity at 12 months of age in the Danish National Birth Cohort

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Abstract

Background/Objectives—Evidence suggests that the child care environment may be more obesogenic than the family home, and previous studies have found that child care use may be associated with obesity in children. Few studies, however, have focused on child care during infancy, which may be an especially vulnerable period. This study examined child care use in infancy and weight status at 12 months of age in a country where paid maternity leave is common and early child care is not as prevalent as in other developed countries.

Subjects/Methods—We studied 27821 children born to mothers participating in the Danish National Birth Cohort (DNBC), a longitudinal study of pregnant women enrolled between 1997 and 2002, who were also included in the Childcare Database, a national record of child care use in Denmark. The exposure was days in child care from birth to 12 months. The outcomes were sex-

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specific body mass index (BMI) z-score and overweight/obesity (BMI 85th percentile based on the World Health Organization classification) at 12 months. We conducted multivariable linear and logistic regression analyses examining child care use and weight outcomes.

Results—A total of 17721 (63.7%) children attended child care during their first year of life. After adjustment for potential confounders, a 30-day increment of child care was associated with a modestly higher BMI z-score at 12 months (0.03 units; 95% CI: 0.01, 0.05; p=0.003). Similarly, child care use was associated with increased odds of being overweight/obese at 12 months of age (OR 1.05; 95% CI: 1.01, 1.10; p=0.047).

Conclusions—Child care in the first year of life was associated with slightly higher weight at 12 months, suggesting that child care settings may be important targets for obesity prevention in infancy.

Keywords

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

Introduction

Obesity rates have increased globally over the past decade, even in young children.¹⁻³ In preschool-aged children, the worldwide prevalence of obesity increased from approximately 4% in 1990 to 7% in 2010.⁴ Rates of obesity are even greater in high-income countries.⁴⁻⁵ Obesity and excessive weight gain in early childhood have been linked to later obesity^{6,7} and chronic health conditions such as diabetes mellitus and cardiovascular disease in adulthood.⁸⁻¹⁰ Even in infancy, excessive weight gain and growth chart percentile crossing has been associated with obesity in later life.¹¹⁻¹⁵ Thus, infancy appears to be a window of opportunity for the prevention of obesity.^{7,15,16}

Child care settings have emerged as important targets for obesity prevention, since large numbers of children, including infants, are cared for regularly outside of the home.^{17,18} There is some evidence that these settings may not provide healthy meals and snacks to children, may encourage sedentary time, and may limit opportunities for active play.^{19,20} In the United States (US), Canada, Hong Kong, the Netherlands, and the United Kingdom (UK), child care use has been associated with obesity, especially in less formal types of care.²¹⁻²⁹ However, one previous study found protective associations with child care use,³⁰ and another found no association.³¹ In the US, we and others have linked child care use during the first year of life to greater weight gain and increased adiposity in later childhood.^{21,23} In other high-income countries, early child care has been inconsistently associated with obesity.^{24,26,29,31}

These previous studies suggest some association between child care use and later obesity, but have yielded mixed results when examining child care during infancy. Moreover, few previous studies have examined early child care use and obesity in countries where child care during the first year of life is not the norm—the majority of studies to date have been conducted in the US, Canada, and the UK. The purpose of this study was to examine associations of time spent in child care during the first year of life, both overall and in

different types of child care, with weight status at 12 months of age in a large cohort of children in Denmark, a setting where paid maternity leave is common and early child care is less prevalent than in other developed countries.

Subjects and Methods

Population and study design

We obtained data from the Danish National Birth Cohort (DNBC), a longitudinal cohort study, and the Childcare Database, a national record of child care attendance in Denmark. The DNBC enrolled 100418 pregnant women between 1997 and 2002, representing approximately 30% of all deliveries in Denmark during those years. Study aims and protocols for this study have been reported previously.^{32,33} Briefly, general practitioners throughout Denmark recruited women at their initial prenatal visit, usually in weeks six to 12 of pregnancy. Participants completed computer-assisted telephone interviews at approximately 12 and 30 weeks gestation and at approximately six and 18 months post-partum. All participants provided informed consent and the Regional Scientific Ethical Committee for the Municipalities of Copenhagen and Frederiksberg approved all study protocols.

The Childcare Database is a record of child care attendance from 1999 through 2004 for all children birth to five years of age from 266 of 271 municipalities in Denmark, representing roughly 90% off all children of this age range in Denmark.³⁴ Municipalities registered children attending child care by type of care, and this information was recorded in the Childcare Database. Although the Database provides data from earlier years, fewer municipalities were represented prior to 1999 and therefore the data were not representative of Denmark as a whole. In the year 2000, 373 142 children were included in the database.

Both the Childcare Database and the DNBC identify individuals by their unique Danish Central Person Register (CPR) number, which makes linkage of data possible.³⁵ The CPR encompasses all persons who have resided in Denmark since April 1,1968, and also includes all new residents and newborns since that time. We merged these datasets by CPR number to select children represented in both datasets. We obtained our exposure variables, the time spent in child care and the type of child care attended during the first year of life, from the Childcare Database. In order to be included in the Childcare Database, children entered child care at some point over their first five years of life, prior to the start of school. All other data, including covariates and the outcome, were obtained from the DNBC and the National Birth Register. Of the 64 592 women who delivered a single, live, full-term (≥ 37 weeks of gestation) infant from the DNBC, we identified 50 766 children represented in both datasets. From these, we excluded 22 991 children for whom information was missing on weight or length and child care use at 12 months, and 2 871 children missing data on child care use only, leaving 27 821 infants for the analysis.

To evaluate the risk of selection bias, we compared the 27 821 children included in this analysis with the 22 945 children who were excluded. More children who were included in the analysis were breastfed for ≥ 22 weeks (28.3% versus 25.7% who were excluded; $p < 0.001$) and had one or more siblings (16.5% versus 13.7%; $p < 0.001$), and fewer were

born to mothers who smoked during pregnancy (15.2% versus 18.6%; $p < 0.001$). The included and excluded children did not differ on the other covariates such as infant sex, gestation length, and family income.

Exposure: Days in child care, overall, and by type of child care

We computed total days in child care from birth to 12 months of age, overall and by each of three types of child care: daycare home, crèche, and age-integrated facility. Infants in Denmark typically attend one of three types of child care: daycare homes (homes that serve less than five children usually of similar ages), crèches (large centers that serve approximately 30-40 children of various ages), or age-integrated facilities (larger centers that serve up to 70 children of different ages) if they are to be cared for outside of the home. The Childcare Database does not include hours children spent in child care or whether the care was full- or part-time. We computed total number of months children attended each of the three types of child care and assumed that children were in care for the entire day.

Outcome: Body mass index z-score

The main outcome was body mass index (BMI) z-score at age 12 months, obtained from the DNBC database. During the 18-month interview, mothers were asked to report their children's height and weight values obtained from the 12-month visit with the physician or public health nurse. We calculated age- and sex-specific 12-month BMI z-scores using World Health Organization (WHO) BMI reference data.³⁶ We further classified children as underweight (<5th percentile), normal weight (5-84th percentile), or overweight/obese (85th percentile) using WHO cutpoints.³⁶

Other covariates

Mothers of children reported their age at conception and parity at the DNBC 12-week gestation interview and their smoking status (which we categorized as never, former, during pregnancy) at the 30-week gestation interview. Mothers reported their height, weight, highest education level achieved, and gross annual household income at the 18-month post-partum interview. Mothers reported their current breastfeeding status, and whether or not they had ever breastfed at the 6-month and 18-month post-partum interviews. Those who were no longer breastfeeding reported the child's age when they had stopped breastfeeding. We calculated the number of weeks infants were breastfed based on this date. We obtained birth data from the National Birth Register including child date of birth, birth weight, and birth length.

Data analysis

To examine variable distribution, we computed means and standard deviations (SD) for continuous demographic variables and frequencies and percentages for categorical variables. To assess differences between characteristics of infants who spent time in child care and those who did not, we conducted analysis of variance (ANOVA) tests for continuous variables and exact Pearson chi-square tests for categorical variables. We used multiple linear regression models to examine the associations between child care use over the first year of life and 12-month BMI z-score. We modeled both the exposure variable of the total

number of months in child care during the first year and our outcome variable of BMI z-score at age 12 months as continuous variables. In multivariable models, we included only those covariates that were of a priori interest. The final multivariable models included maternal age, smoking during pregnancy, parity, and pre-pregnancy BMI; family income; breastfeeding; and infant birth weight.

For the analyses of type of child care, because children could spend time in more than one type of child care over the year, we examined each of the three types of child care in a combined linear regression model, using the same covariates. We used 12-month BMI z-score as the primary outcome. Additionally, we conducted logistic regression analyses examining the odds of children being overweight/obese at 12 months of age, overall in one model and by type of child care in a separate model that combined all three types of child care. We conducted all analyses using SAS version 9.2 (SAS Institute, Cary, North Carolina, US).

Results

A total of 17 721 (63.7%) children attended child care at some point during their first 12 months of life (Table 1). Of those, children spent an average (SD) of 2.6 (2.5) months in a daycare home, 0.4 (1.2) in a crèche, and 1.5 (1.4) in an age-integrated facility—children could spend time in more than one type of child care over the course of the 12 months. Infants in child care started care, on average, at 5.7 (7.5) months of age. Children in child care were less often breastfed for ≥ 22 weeks (24.4% vs. 35.1%; $p < 0.0001$) and more children came from families with higher household incomes (534 540 Danish Kroner vs. 507 218 Danish Kroner; $p < 0.0001$), compared to children cared for at home by a parent. These household incomes convert to roughly \$90,000 USD and \$86,000 USD, respectively. Fewer children in child care were female (48.4% vs. 49.8%; $p = 0.001$), but the two groups did not differ on other demographic variables.

All covariates identified a priori were significant predictors of 12-month BMI except parity, although parity was also included in the adjusted models. After adjustment for potential confounders, any child care use was associated with 0.03 units higher BMI z-score at 12 months for each additional 30 days of care (95% CI: 0.01, 0.05) (Table 2). Care in a daycare home (0.03 units; 95% CI: 0.01, 0.05), crèche (0.05 units; 95% CI: 0.01, 0.10), and age-integrated facility (0.08 units; 95% CI: 0.04, 0.12) were each associated with a higher BMI z-score at 12 months.

In adjusted logistic regression analyses, for every additional 30 days of care, child care use was associated with a slightly higher odds of being overweight/obese at 12 months (OR 1.05; 95% CI: 1.01, 1.10) (Table 3). Care in an age-integrated facility was associated with a 1.15 higher odds of being overweight/obese (95% CI: 1.06, 1.27) and was the only type of care associated with the outcome modeled as a categorical variable.

Discussion

We found that child care attendance in infancy was associated with a higher BMI z-score at 12 months of age. Care in a daycare home, age-integrated facility, and crèche were each

associated with a higher BMI z-score. When we examined overweight/obesity as a categorical outcome, care in a daycare home and crèche were not associated with higher odds of overweight/obesity at 12 months. It is important to consider the clinical relevance of these findings. For a 12-month-old male with an average weight and length within the dataset, an increase of 0.08 units for every additional 30 days in age-integrated child care (findings from this study) resulted in a modest increase from the 64th percentile to the 68th percentile on the WHO BMI-for-age percentile growth charts. While these effects may be small, cumulative exposure to child care over time may amount to a more substantial clinical difference in weight status.

In Denmark, the age-integrated facility is the least common and daycare homes are the most common type of child care used by infants.³⁴ Daycare homes are more informal and the smallest facilities, caring for just a few children. They also tend to care for children of similar ages, so infants are likely cared for with other infants.³⁴ In our analyses, we found an association between care in a daycare home and crèche and the 12-month weight outcome when BMI was modeled as a continuous variable, but not as a categorical variable. This may be due in part to the small effect sizes observed in linear regression models, which could be reflective of a chance finding, given the large sample size. Care in an age-integrated facility was the only type of care associated with the outcome in all analyses. Age-integrated facilities are the largest child care settings in Denmark, caring for roughly 70 children at any one time. As has been hypothesized previously,²³ providers who care for a group of children of different ages may be more likely to advance infants beyond their developmental readiness to help match the feeding of older children. This may result in the early introduction of solid foods or other inappropriate feeding practices such as bottle propping. Additionally, infants may experience prolonged inactivity in a crib or high chair, if providers are busy minding older children.

Previous studies found that less formal types of care, such as care provided by a family member, friend, or neighbor, or care in a family child care home, had the biggest impact on weight gain and rates of obesity.^{21-23,26-29} Our results are somewhat contradictory to these previous studies in that care in the largest child care facility was associated with a higher odds of being overweight or obese in our analysis, whereas care in the smallest type of facility was not. We did not have data on informal care in our sample, but this type of child care is not as common in Denmark.³⁴ Previous studies in the US and the UK found that relative care was the type of care most associated with obesity in children.^{21,26,27}

A limitation of this study is that we were not able to include other measures of child dietary intake beyond breastfeeding duration, nor were we able to assess energy expenditure and sedentary time while children were in care. These behaviors may be in the causal pathway leading to the development of obesity, if child care providers engage in less healthy infant feeding and physical activity practices. Infant stress may also play a role in the development of obesity; several studies demonstrate a potential link between elevated cortisol levels and increased abdominal obesity.³⁷⁻³⁹ A growing body of evidence suggests a relationship between child care and elevated cortisol levels, even in very young children.⁴⁰⁻⁴³ However, we did not have markers of stress in infants in the cohort. Additionally, we did not have information on the intensity of child care, and thus, we were not able to compare part-time

to full-time care, as was done in previous studies.^{21,30} Instead, we assumed that children in child care were in care for the entire day, which may not have been the case. We also lost a substantial number of children that could have been included in the analysis when we merged the DNBC with the Childcare Database. We limited our sample to children who were included in the Childcare Database, meaning they spent time in child care at some point prior to entering school. We wanted to compare infants who spent time in child care during the first year of life to other infants who were not in child care initially, but would later enter care sometime after 12 months of age, as parents who use child care are likely more similar to each other than parents who opted not to use child care at all for their children.

We also relied on parents to report their children's 12-month length and weight collected by a physician or public health nurse. This may limit accuracy, since these measures were not conducted by a trained researcher. Additionally, the Childcare Database does not include child care attendance data from five of the 271 municipalities in Denmark. Based on Danish standards of population size, two of these municipalities were large, two were medium-sized, and one was small.³⁴ This may introduce a slight under-representation of children from large municipalities. Such under-representation, however, would affect estimation of the association between child care and obesity only if it was modified by the population size in the municipality, which we have no reason to suspect. Finally, while the large sample size and use of two national datasets enhances generalizability to Denmark, results may not be applicable to other countries. However, no previous studies have examined child care use in Scandinavian countries. Two European cohorts have provided information about the relationship between child use and obesity. In the Dutch KOALA birth cohort, researchers found that child care use was associated with obesity at age two years, but they were not able to examine types of child care.²⁴ In the Millennium Cohort Study in the UK, informal child care was the only type of care associated with obesity.²⁶

Although obesity rates in children had been rising in Denmark,⁴⁴⁻⁴⁷ a recent study suggests that over the last decade rates of obesity in childhood decreased, while rates in infancy may have plateaued.⁴⁸ However, these studies have not compared obesity rates of children using child care versus those cared for at home by a parent. Child care use in infancy was low in our sample, compared to use in previous studies in the US, Canada, and the UK.^{21,23,26,29} Two previous studies, both in the US, have examined very early child care, i.e., use during the first six months of life. A single study in the Netherlands examined child care at seven months of age and found no association with BMI z-score at age two years.²⁴ Here, we found that greater child care use in the first year of life, especially in an age-integrated facility, was associated with a higher BMI z-score and higher odds of being overweight/obese at 12 months. Our study and previous studies, however, were not able to determine whether families with a particular unmeasured characteristic that may itself be related to obesity were more likely to choose child care or select a particular type of child care. Our current study did not assess reasons why parents selected certain types of child care over others, or why some families opted against child care during the first year of life.

The Ministry of Social Welfare in Denmark offers a total of 24 weeks of paid maternity leave with full salary and 28 additional weeks with a public (often lower) salary.⁴⁹

Additionally, children are entitled to government-supported care from 26 weeks of age until they begin primary school. However, there is a fee associated with child care, and that may influence the decision to enroll children at later ages. Based on a 2011 government report, 70% of Danish children less than two years attended a publicly supported child care facility.³⁷ Two percent of children were enrolled before three months of age, but 21% had enrolled by six months of age.³⁴ In our study, care during the first six months of life was less common, with 12.4% of children using some type of child care prior to six months of age.

Our findings indicate that child care use in infancy was associated with slightly higher BMI z-scores and somewhat greater odds of being overweight or obese at 12 months of age. While the BMI z-score regression coefficient estimates and odds ratios were relatively small, they are consistent with those found in a previous study examining child care use in the Netherlands.²⁴ These results represent modest, but perhaps important differences in weight status. Over time, the cumulative effect of additional time in child care may have a substantial impact on weight status. Early childhood may provide a window of opportunity for the prevention of obesity and the first year represents an especially critical period.¹⁵ A number of interventions have targeted child care facilities for obesity prevention,⁵⁰⁻⁵⁵ but to our knowledge only one has focused on infants.⁵⁵ Results from this study support recent calls for intervention efforts to improve the child care setting.^{19,20} Creating healthier environments where infants spend time may help prevent the development of obesity in very young children.

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Table 1

Child and family characteristics of participants in the Danish National Birth Cohort and the Childcare Database of Denmark (n=27 821)

	Any Child Care (n=17 721)		No Child Care (n=10 100)	
Child Characteristics	Mean	SD	Mean	SD
Birth weight, grams	3597.3	544.6	3593.0	590.3
Gestational age at birth, weeks	40.1	1.6	39.9	1.8
Child care use, months	3.5	2.2	--	--
Daycare home	2.6	2.5	--	--
Crèche	0.4	1.2	--	--
Age-integrated facility	1.5	1.4	--	--
Age entered child care, months	5.7	7.5	--	--
Parental care at home, months	8.6	2.2	12.0	0.0
Child age at 12-month assessment, months	12.5	0.8	12.4	0.7
12-month BMI z-score	0.3	1.1	0.3	1.1
12-month assessment weight, kg	10.3	1.2	10.2	1.2
12-month assessment length, cm	77.6	3.1	77.5	3.1
	Number	Percent	Number	Percent
Sex, female	7192	48.3	4339	50.5
12-month BMI weight category				
Underweight, <5 th percentile	1207	6.8	749	7.4
Normal weight, 5-84 th percentile	12258	69.2	7019	69.5
Overweight, 85-94 th percentile	2397	13.5	1334	13.2
Obese, 95 th percentile	1859	10.5	998	9.9
Breastfeeding duration, weeks				
0-13	4350	29.3	2205	25.7
14-21	6880	46.3	3361	39.2
22	3632	24.4	3009	35.1
Maternal Characteristics	Mean	SD	Mean	SD
Age, years	30.6	4.0	31.1	4.3
Pre-pregnancy BMI, kg/m ²	23.5	4.0	23.4	4.3
Household income, Danish Kroner	534540.7	198767.7	507218.6	288024.8
	Number	Percent	Number	Percent
Smoked during pregnancy				
No	14376	84.9	8178	84.6
Yes	2549	15.1	1493	15.4
Parity				
0	8722	51.0	4421	45.3
1	6141	35.9	3151	32.3

Child Characteristics	Any Child Care (n=17 721)		No Child Care (n=10 100)	
	Mean	SD	Mean	SD
2	2240	13.1	2193	22.5

BMI, body mass index

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Unadjusted and multivariable adjusted regression estimates and 95% confidence interval (CI) of associations of child care during the first year of life, per increment of 30 days of care, with body mass index z-score at 12 months of age

Table 2

Type of care	Body Mass Index z-score					
	Unadjusted (n=17 721)			Adjusted ^a (n=17 701)		
	Estimate	95% CI	p-value	Estimate	95% CI	p-value
Any child care	0.05	0.03, 0.07	<0.001	0.03	0.01, 0.05	0.003
Daycare home	0.04	0.02, 0.06	<0.001	0.03	0.01, 0.05	0.02
Crèche	0.06	0.02, 0.11	0.004	0.05	0.01, 0.10	0.03
Age-integrated	0.08	0.04, 0.11	<0.001	0.08	0.04, 0.12	<0.001

^a Adjusted for maternal age, smoking during pregnancy, parity, and pre-pregnancy body mass index; household income; breastfeeding; and infant birth weight.

Unadjusted and adjusted odds ratios and 95% confidence interval (CI) for overweight/obesity at 12 months of age by type of child care during the first year of life, per increment of 30 days of care

Table 3

Type of care	Overweight/obesity					
	Unadjusted (n=17 721)			Adjusted ^a (n=16 987)		
	Odds Ratio	95% CI	p-value	Odds Ratio	95% CI	p-value
Any child care	1.07	1.03, 1.10	<0.001	1.05	1.01, 1.10	0.047
Daycare home	1.07	1.03, 1.11	<0.001	1.05	0.99, 1.10	0.06
Crèche	1.06	0.98, 1.12	0.12	1.05	0.95, 1.16	0.35
Age-integrated	1.13	1.06, 1.22	<0.001	1.15	1.06, 1.27	0.001

^a Adjusted for maternal age, smoking during pregnancy, parity, and pre-pregnancy body mass index; household income; breastfeeding; and infant birth weight.