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Day care attendance and risk for respiratory morbidity among young very low birth weight children

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Summary

Daycare attendance and very low birth weight (VLBW, ≤ 1500 grams) are associated with respiratory morbidity during childhood. The objective of this study was to evaluate whether daycare attendance is associated with even higher risk for respiratory problems among VLBW children. We hypothesized that VLBW children attending daycare, in a private home or daycare center, are at higher risk for respiratory problems than VLBW children not attending daycare. We also investigated whether the effect of daycare is independent or synergistic with respiratory risk resulting from being VLBW, as indicated by having bronchopulmonary dysplasia (BPD) as a neonate. We conducted a prospective study of VLBW children followed from birth to age 2–3 (N=715). Logistic regression was used to evaluate the relationship between daycare attendance and respiratory problems, adjusting for known neonatal risk factors for poor respiratory outcomes. Attending daycare in either a private home or in a daycare center was significantly associated with higher risk of lower respiratory infections than never attending. Attending a daycare center was also associated with higher risk for wheezy chest, cough without a cold, and respiratory medication use. While having BPD was associated with increased risk for respiratory problems, daycare attendance and BPD were not found to be synergistic risk factors for respiratory problems among VLBW children, but acted independently to increase risk. This implies that the increase in risk for respiratory problems associated with daycare attendance may be similar among VLBW children and those of normal birth weight.

Keywords

Very low birth weight; Respiratory morbidity; Child daycare centers; Population-based study

Introduction

Studies have found that daycare center attendance is associated with higher risk for wheezing and lower respiratory infections at age two to three years.^{1, 2} However, a recent study followed children into later childhood and found that while respiratory symptoms at age two to three are more prevalent among children attending daycare, by age six, there seems to be a protective effect of early-life daycare center attendance.³ This study was done among children who had at least one parent with a history of asthma or allergy. The relationship between daycare attendance and respiratory morbidity has not been investigated among premature, very low birth weight (VLBW, ≤ 1500 grams) children who may have similar vulnerabilities as children

with a family history of asthma. VLBW children are at risk for chronic lung disease, such as bronchopulmonary dysplasia (BPD), during infancy⁴ and low lung function and respiratory illness during childhood.^{5–7} Thus, it is important to investigate whether daycare attendance may put these children at even higher risk for respiratory morbidity.

The Newborn Lung Project is a statewide cohort of VLBW children in Wisconsin, who are followed into childhood to evaluate health and functional outcomes.⁸ Our rich data set allows us to investigate several aspects of daycare and to take into account several known risk factors for respiratory problems. We hypothesized that children who attend daycare, either in a private home or at a center, are at higher risk for respiratory problems, including wheezing, coughing, asthma attacks, lower respiratory infections (LRI), medication use, and respiratory related hospitalizations, than children who do not attend daycare; and that greater exposure to daycare, in terms of hours per week, age when daycare attendance began, and higher numbers of children at the daycare, is associated with higher risk for respiratory problems. We also investigate whether the effect of daycare is independent or synergistic with respiratory risk resulting from being VLBW, as indicated by having BPD as a neonate. Additionally, we explore the relationships between respiratory symptoms and family and sociodemographic variables suspected to be risk factors for respiratory problems, in this population of VLBW children.

Materials and Methods

Study sample and data collection

The Newborn Lung Project Statewide Cohort is a prospective study of all VLBW infants admitted to the 16 level III neonatal intensive care units (NICU) in Wisconsin 1/1/2003 – 12/31/2004. Wisconsin residents admitted to a level III NICU in Duluth, Minnesota were also included in the cohort. Anonymous neonatal data were collected from the medical records of all admitted VLBW infants by designated NICU nurses. Nurses also approached parents for consent to collect identifiable data from the medical record and to obtain contact information for follow-up. Trained interviewers collected data on respiratory outcomes and family, household, and sociodemographic information through parent telephone interviews when children were two to three years old (mean (standard deviation, SD) 32.2 (3.5) months corrected age; range 25.0–46.3 months).

Variable definitions

The following respiratory outcomes were evaluated: at least one wheezing episode during the past 12 months, at least one period of coughing without a cold during the past 12 months, and at least one asthma attack during the past 12 months. Frequent wheeze, cough, or asthma attacks were defined as having experienced four or more episodes in the past 12 months. LRI since NICU discharge, respiratory medication use during the first two years of life (defined as taking bronchodilators or steroids for at least two weeks during each of the first two years of life), and respiratory-related hospitalization during the first two years of life were also evaluated.

BPD was defined as oxygen use at 36 weeks postmenstrual age. Daycare attendance was evaluated as ever attending a daycare center or ever attending a private home daycare. Among children who ever attended either type of daycare, the following characteristics were evaluated: the hours per week the child attended daycare (measured per 10 hours per week), the age in months the child started attending daycare, and the number of children who attended the daycare facility (evaluated with the categories 0–1 other children, 2–6 other children, 7–10 other children, 11–15 other children, and more than 15 other children).

The following family and sociodemographic variables were evaluated, based on their previously found association with respiratory outcomes among populations of normal

birthweight children: the number of children living in the child's primary home, parental history of asthma, maternal education (some college/tech school or beyond compared to a high school degree or less), race (black vs other), family income (measured in \$10,000 increments), maternal smoking during pregnancy, whether someone smokes in the primary residence, and whether there are pets (cat, dog, bird, or other furry pet) in the primary residence.

Statistical Analysis

Statistical analyses were performed using SAS, version 9.1 (SAS Institute Inc., Cary, North Carolina). We used logistic regression to evaluate associations between respiratory outcomes and BPD, daycare attendance, and daycare characteristics. The associations between respiratory outcomes and family, household, and sociodemographic variables were similarly evaluated with logistic regression.

All models were adjusted for known neonatal risk factors for poor respiratory outcomes, including gestational age, sex, BPD, and the Score for Neonatal Acute Physiology, Version II (SNAP-II). SNAP-II is an index of newborn illness severity based on physiological measurements from the first 12 hours after birth.⁹ We evaluated whether there were interactions between BPD status and daycare attendance for each of the respiratory outcomes.

Models were refit, weighted by the inverse probability of participation in follow-up, to assess whether participation bias may have affected the conclusions.

Results

There were 1479 VLBW infants admitted to the study NICUs during the recruitment period. Of these, 993 infants survived to discharge from the NICU and had parents who provided re-contact information and consent for future follow-up. Fourteen children died after discharge, leaving 979 children for possible follow-up. The parents of 26 children refused to participate in the follow-up interview, 9 did not complete the interview after they consented to do so, and 225 were lost or did not respond to mailings or phone calls. Therefore, 719 children were followed to age 2–3. Four children had missing data for daycare status and were excluded, leaving 715 children in the analyses.

There were 369 children (52% of sample) who never attended daycare and 346 children who ever attended some kind of daycare. Forty-two children attended both a private home daycare and a daycare center at some point between birth and follow-up; all these children were attending daycare at the time of the interview and were analyzed according their current daycare type. There were 180 children (25% of sample) in the private home daycare group, and 166 children (23% of sample) in the daycare center group. Children who ever attended daycare had higher birth weights and gestational ages and better SNAP-II scores than children who never attended daycare (Table 1). There were fewer children in the household among those who ever attended daycare, and mothers of children who attended daycare had higher education than those of children who never attended daycare (Table 1).

The Figure shows the percentage of children who experienced respiratory problems by daycare status. Children who never attended either type of daycare were least likely to experience wheezing, cough without a cold, asthma attack, and LRI, while children who attended daycare centers were most likely to experience these respiratory problems. The prevalence of respiratory medication use was similar among children who never attended daycare and children who attended daycare in a private home, while the prevalence of use was higher among children who attended daycare centers. Respiratory-related hospitalizations were most frequent among children who never attended daycare and least frequent among children in daycare centers.

BPD was significantly associated with all respiratory outcomes evaluated (Table 2). The relationship between daycare attendance and respiratory problems was evaluated, taking into account neonatal factors. Children who attended daycare in a private home were significantly more likely to have an LRI than children who never attended daycare, but private home daycare was not significantly associated with any other respiratory problems (Table 2). Children who attended daycare centers were significantly more likely to experience all of the respiratory outcomes that were evaluated, except for respiratory related hospitalizations (Table 2). There were no interactions between BPD status and daycare attendance for any of the respiratory outcomes (data not shown).

In a subgroup analysis of the 346 children who attended daycare, respiratory problems were not significantly associated with the age at which daycare attendance began or the number of hours per week spent in daycare, after adjusting for neonatal variables and respiratory risk factors. A higher number of children in the daycare was associated with higher risk for having a cough without a cold, having an asthma attack, and having frequent wheeze, cough, or asthma attack (Table 3).

With each additional sibling in the household, the odds of experiencing each of the evaluated respiratory problems was higher. Having a parent with a history of asthma was also associated with higher risk for experiencing each of the respiratory problems, except for having a respiratory related hospitalization. Black children were significantly more likely to use respiratory medications than other children and showed a trend toward being at higher risk for wheezy chest and asthma attacks. Higher family income was associated with lower risk for asthma attacks and LRIs, while maternal education was not significantly associated with any of the respiratory problems (Table 4). Prenatal maternal smoking was significantly associated with wheezy chest, having a cough without a cold, and taking respiratory medications, while children who lived with someone who smoked showed a trend toward being at higher risk for these outcomes, in addition to LRIs. Living with a pet was not associated with higher risk of respiratory problems (Table 4).

Weighting models by the inverse of the probability of participation in the follow-up interview at age 2–3 did not affect the conclusions for the relationship between daycare attendance and any of the respiratory problems.

Discussion

This study suggests that VLBW children who attend daycare are at higher risk for respiratory problems than VLBW children who have never attended daycare. Attending a daycare center is associated with higher risk for respiratory problems than being cared for in a private home.

The association between attending a daycare center and respiratory problems was similar among children in our cohort of VLBW children (OR=2.5, 95% CI=1.2, 3.3 for LRI) and in a cohort of full term children with at least one parent with a history of asthma (OR=1.6, 95% CI=1.0–2.4 for LRI).¹ The relationship between daycare attendance and LRIs among children in these more vulnerable populations was about the same as that in a cohort of children who belonged to a health maintenance organization (OR=2.0, 95% CI=1.7–2.2 for LRI).²

As BPD is a major risk factor for childhood respiratory morbidity among VLBW children,¹⁰ we evaluated whether there was an interaction between BPD status and daycare attendance. Daycare attendance and BPD were not found to be synergistic risk factors for respiratory problems among VLBW children, but acted independently to increase risk. This supports the observation that the increase in risk associated with daycare attendance may be similar among VLBW and normal birth weight.

Studies of normal birth weight children have also found that daycare center attendance is associated with higher risk for respiratory morbidity than attending a private home daycare.^{1, 2, 11, 12} It seems likely that this is due to the greater number of children and staff that center attendees come into contact with compared to children who are cared for in someone's home. This explanation is supported by our finding that, among children who attended some kind of daycare, greater numbers of children in the daycare were associated with a significantly higher risk for coughing without a cold and asthma attacks. Our finding that having a higher number of siblings was significantly associated with higher risk for respiratory problems is also consistent with this explanation. However, other measures of daycare exposure, including the age daycare started and the hours per week spent there, were not associated with respiratory problems in our study.

The results of other studies that have evaluated the relationship between exposure to other children at daycare and risk for respiratory problems have been mixed. A study of children age 0–2 years in a Minnesota health maintenance organization found that the risk of LRIs was not affected by the number of children at the daycare or the number of hours per week the child spent at the daycare.² In contrast, a study of children enrolled in a health maintenance organization in Tucson found that among children aged 4 months to 3 years, those who were cared for along with 3 or more other children (siblings or unrelated children at home or center daycare) were more likely to have an LRI than children cared for in the presence of less than 3 other children.¹³

The relationship between number of siblings and risk for respiratory problems seems to depend on the age of the child at risk. One study found that exposure to siblings increased risk for respiratory illness among children aged 6 weeks through 17 months,¹⁴ but that for children aged 36–59 months, exposure to siblings was protective for respiratory illness. This finding is consistent with another study that found that having more siblings is associated with lower risk for asthma at age 5.¹⁵ However, no association was found between number of siblings and asthma or recurrent wheezing in a different study that evaluated children at age 6.³ At about age 2, contact with higher numbers of children, either siblings or non-related children in a daycare setting, was associated with higher risk for respiratory problems among VLBW children in our cohort. It will be important to evaluate our cohort of VLBW children later in childhood to determine whether the risk for respiratory problems diminishes with age for this vulnerable population of children.

In our exploratory analyses of commonly suspected risk factors for respiratory problems among full term children, we found socioeconomic level and parental asthma history to be associated with several of our outcomes. We did not find an association between having a pet in the primary residence and higher risk for respiratory problems, consistent with several recent studies.^{16–18} However, other studies that have followed children longer have found an association between pet exposure and respiratory problems, and results have been mixed. Early exposure to pets was protective for asthma at pre-school/early school age in some studies.^{19, 20} while it was found to increase risk for asthma in another study.²¹ It is possible that the null relationship we found could be because we were not able to take into account other places children may have had exposure to pets (ie, regular visits to or from neighbors or relatives) or because these respiratory problems do not show up until later in childhood.

Exposure to secondary environmental tobacco smoke (ETS) has been documented as a major risk factor for respiratory symptoms in children.^{22, 23} While we found associations between maternal smoking during pregnancy and respiratory outcomes, the association with ETS was not statistically significant, although it was in the expected direction. We suspect that, since very few interviewees reported ETS, our study may have been underpowered to detect the association. The association with found with smoking during pregnancy may reflect direct

exposure of the child to smoke after birth or pregnancy related effects. Exposure to maternal smoking may be speculated to have stronger effect than general ETS exposure, although a report in the literature did not confirm this.²³ It is also possible that some parents whose children have respiratory symptoms avoid smoking in the home.²⁴

The major strength of this study is that we have a relatively large population-based cohort of VLBW children. We were able to collect data on several kinds of respiratory problems, details of daycare attendance, and information about exposure to several other respiratory risk factors from this statewide cohort of children.

This study does have some limitations. First, all data were obtained through parental report. However, while it may be difficult to recall the exact timing of a wheezing episode or an LRI, it is likely not difficult to remember that these episodes occurred. We examined several outcomes to confirm results, and found a general consistency in associations. Moreover, any errors in recall are not likely to be differential with respect to daycare attendance status. It could be argued that parents with their children in daycare may be more likely to take their children to the doctor, and thus more likely to receive a diagnosis or a prescription for a respiratory medication, in order to be able to take them back to daycare sooner. If this was true in our sample, then the association between daycare attendance and, in particular, LRI and respiratory medication use, may be somewhat overestimated.

Additionally, follow-up data were collected at a single time-point, when the children were 2–3 years old. We were not able to take into account changes in exposures over this time period. However, it is likely that any systematic changes in exposures would be the reduction or elimination of negative exposures among children experiencing poor respiratory outcomes. Resulting misclassification of children who had been exposed previously, but who were not exposed at the time of the follow-up interview, would bias our results toward the null. Consequently, our findings may underestimate the relationship between exposures and respiratory outcomes.

Like their full-term counterparts, VLBW children who attend daycare, especially in a center setting, are at higher risk for respiratory problems than VLBW children who have never attended daycare. Further follow-up of this vulnerable population is warranted to determine whether early daycare exposure continues to be associated with higher risk for respiratory morbidity or whether it is protective for later childhood respiratory morbidity, as may be the case for the normal birth weight population. The results of this continued follow-up may help inform decisions about where VLBW children are cared for during the first years of their lives.

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Figure 1. Percentage of children who experienced respiratory problems by daycare status

Wheezy chest, cough without a cold, asthma attack, and frequent wheeze, cough or asthma were evaluated during the 12 months prior to interview. Lower respiratory infections (LRI) were evaluated between discharge from the neonatal intensive care unit and the time of the interview. Respiratory medications, and respiratory related hospitalizations were evaluated during the first two years of life.

TABLE 1

Baseline characteristics, household characteristics, and respiratory symptoms for very low birth weight children in the Newborn Lung Project by daycare attendance

	Never attended daycare	Attended daycare in private home	Attended daycare center
N	369	180	166
Baseline characteristics			
Birth weight	1053 ± 288	1104 ± 268 ^a	1101 ± 274
Gestational age	28.1 ± 2.8	28.7 ± 2.8 ^a	28.5 ± 2.6
Male	190 (51)	81 (45)	75 (45)
BPD ^b	113 (42)	45 (37)	47 (41)
SNAP-II ^c	16.3 ± 13.4	15.1 ± 13.4	13.8 ± 11.9 ^a
Prenatal maternal smoking	66 (18)	25 (14)	20 (12)
Family and sociodemographic characteristics			
Number of children	1.2 ± 1.2	0.82 (0.97) ^a	0.90 (1.2) ^a
Parent history of asthma	80 (22)	37 (21)	49 (30)
Maternal education			
≤High school	137 (37)	73 (21) ^a	39 (23) ^a
≥Some college	230 (63)	143 (79)	127 (77)
Family income	48,000 ± 29,000	55,000 ± 27,000 ^a	56,000 ± 32,000 ^a
Someone smokes in primary residence	18 (5)	9 (5)	13 (8)
Pet ^d lives in primary residence	183 (50)	94 (52)	76 (46)

^a p<0.05 for difference with never attended daycare

^b bronchopulmonary dysplasia

^c Score for Neonatal Acute Physiology, II

^d dog, cat, bird, or other furry pet

TABLE 2

Odds ratios (95% confidence interval) for respiratory problems comparing children with and without BPD and children who attended daycare to those who did not (n=715)

	BPD^a	Ever attended private home daycare^{b,c}	Ever attended daycare center^{b,c}
Respiratory Outcomes			
Wheezy chest ^d	2.3 (1.4, 3.7)	1.4 (0.81, 2.4)	3.0 (1.7, 5.3)
Cough without cold ^d	2.0 (1.04, 3.8)	1.1 (0.50, 2.3)	4.7 (2.4, 9.1)
Asthma attack ^d	1.2 (0.51, 2.7)	1.6 (0.63, 4.1)	3.7 (1.7, 8.4)
Frequent wheeze, cough, or asthma attack ^e	2.1 (1.2, 3.7)	1.0 (0.53, 2.0)	3.4 (1.8, 6.2)
LRF ^f	1.5 (1.0, 2.5)	2.2 (1.4, 3.6)	3.0 (1.8, 5.0)
Respiratory medication use	2.8 (1.7, 4.5)	1.1 (0.67, 1.9)	2.7 (1.6, 4.8)
Respiratory related hospitalization	2.4 (1.4, 4.3)	0.99 (0.54, 1.8)	0.69 (0.35, 1.4)

^a Models adjusted for gestational age, sex, SNAP-II, maternal education, race, family income, smoking in the home, pets in the home, parental history of asthma, and number of siblings, and daycare attendance

^b Models adjusted for gestational age, sex, SNAP-II, BPD, maternal education, race, family income, smoking in the home, pets in the home, parental history of asthma, and number of siblings

^c Comparison group is children who never attended daycare

^d ≥ 1 episode in last 12 months

^e ≥ 4 episodes in last 12 months

^f lower respiratory infection

TABLE 3

Odds ratios^a (95% confidence intervals) for respiratory symptoms by daycare characteristics among children who ever attended daycare (n=346)

	Per age (months) at start of daycare	Per 10 hrs/wk	Per each other child attending the daycare
Respiratory Outcomes			
Wheezy chest ^b	0.96 (0.93, 1.0)	1.1 (0.91, 1.3)	1.3 (0.93, 1.7)
Cough without cold ^b	1.0 (0.97, 1.1)	1.2 (0.94, 1.5)	1.7 (1.2, 2.4)
Asthma attack ^b	1.0 (0.94, 1.1)	1.3 (0.93, 1.7)	1.8 (1.1, 2.9)
Frequent wheeze, cough, or asthma attack ^c	1.0 (0.97, 1.1)	1.0 (0.83, 1.2)	1.6 (1.1, 2.3)
LRI ^d	0.97 (0.93, 1.0)	1.2 (0.99, 1.4)	1.3 (0.97, 1.9)
Respiratory medication use	0.98 (0.94, 1.0)	1.1 (0.88, 1.3)	1.0 (0.75, 1.4)
Respiratory related hospitalization	0.97 (0.92, 1.0)	0.85 (0.66, 1.1)	0.72 (0.46, 1.1)

^a Models adjusted for gestational age, sex, SNAP-II, BPD, maternal education, race, family income, smoking in the home, pets in the home, parental history of asthma, and number of siblings

^b ≥ 1 episode in last 12 months

^c ≥ 4 episodes in last 12 months

^d lower respiratory infection

TABLE 4

Odds ratios^a (95% confidence intervals) for respiratory symptoms by family and sociodemographic variables (n=715)

	Number siblings	Parent history of asthma	Black race	Family income ^b	Maternal edu, ≥Some college ^c	Prenatal smoking	Smoking in home	Pets in home
Respiratory Outcomes								
Wheezy chest ^d	1.3 (1.1, 1.6)	1.9 (1.2, 3.1)	1.7 (0.79, 3.6)	0.97 (0.89, 1.1)	1.1 (0.62, 1.9)	1.9 (1.02, 3.4)	1.9 (0.55, 6.3)	0.99 (0.64, 1.5)
Cough without ^d cold	1.5 (1.2, 1.9)	1.8 (0.98, 3.2)	1.0 (0.44, 2.5)	0.89 (0.79, 0.99)	1.4 (0.71, 2.8)	2.1 (1.03, 4.3)	2.0 (0.44, 8.7)	0.92 (0.52, 1.6)
Asthma attack ^d	1.4 (1.1, 1.8)	2.4 (1.2, 4.9)	1.6 (0.59, 4.1)	0.69 (0.58, 0.82)	2.2 (0.97, 5.0)	1.6 (0.67, 3.7)	1.2 (0.23, 6.3)	0.81 (0.39, 1.7)
Frequent wheeze, cough, or asthma attack ^e	1.5 (1.2, 1.9)	1.9 (1.1, 3.3)	1.4 (0.65, 3.1)	0.92 (0.83, 1.0)	0.86 (0.47, 1.6)	1.5 (0.75, 2.9)	1.7 (0.45, 6.4)	0.79 (0.48, 1.3)
LR ^f	1.3 (1.1, 1.5)	1.9 (1.2, 3.0)	0.93 (0.45, 1.9)	0.91 (0.84, 0.99)	1.9 (1.1, 3.2)	1.1 (0.65, 2.0)	2.0 (0.61, 6.4)	1.0 (0.68, 1.5)
Respiratory medications	1.3 (1.04, 1.5)	2.0 (1.2, 3.3)	2.8 (1.2, 6.4)	0.98 (0.90, 1.1)	0.83 (0.48, 1.4)	3.0 (1.6, 5.6)	1.5 (0.42, 5.1)	0.96 (0.63, 1.5)
Respiratory related hospitalizations	1.4 (1.1, 1.6)	1.1 (0.62, 1.9)	1.0 (0.43, 2.3)	0.88 (0.79, 0.98)	1.4 (0.76, 2.5)	1.2 (0.61, 2.3)	1.5 (0.39, 5.8)	1.0 (0.62, 1.7)

^a Models adjusted for gestational age, sex, SNAP-II, BPD, daycare attendance, and each of the other family and sociodemographic variables shown in the table

^b per \$10,000

^c compared to ≤ high school

^d ≥ 1 episode in last 12 months

^e ≥ 4 episodes in last 12 months

^f lower respiratory infection