

Day Care Centers and Respiratory Health

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ABSTRACT. *Objective.* To estimate the effects of the type of day care on respiratory health in preschool children.

Methods. A population-based cross-sectional study of Oslo children born in 1992 was conducted at the end of 1996. A self-administered questionnaire inquired about day care arrangements, children's health, environmental conditions, and family characteristics ($n = 3853$; response rate, 79%).

Results. In logistic regression controlling for confounding, children in day care centers had more often nightly cough (adjusted odds ratio, 1.89; 95% confidence interval, 1.34–2.67), and blocked or runny nose without common cold (1.55; 1.07–1.61) during the past 12 months compared with children in home care. Poisson regression analysis showed an increased risk of the common cold (incidence rate ratio, 1.21; 1.12–1.30) and otitis media (1.48; 1.22–1.80), and the attributable proportion was 17.4% (95% confidence interval, 10.7–23.1) for the common cold and 32.4% (18.0–44.4) for otitis media. Early starting age in the day care center increased the risk of developing recurrent otitis media. Also the lifetime risk of doctor-diagnosed asthma was higher in children who started day care center attendance during the first 2 years of life.

Conclusions. Attendance to day care centers increases the risk of upper respiratory symptoms and infections in 3- to 5-year-old children. The starting age seems to be an important determinant of recurrent otitis media as well as asthma. The effect of day care center attendance on asthma is limited to age up to 2 years. This effect is most likely mediated via early respiratory tract infections that are substantially more common in children in day care centers compared with children in home care. *Pediatrics* 1999;103:753–758; children, respiratory health, asthma, otitis media, day care.

ABBREVIATIONS. AP, attributable proportion; IR, incidence rate ratio.

ence of pets, and air pollution are now well established.^{1–10} During past decades the western world has seen an increasing proportion of mothers of young children entering the workforce and, consequently, a larger proportion of children attending day care outside the home.¹¹ Day care centers now constitute an important common childhood environment, where children may be exposed to conditions that may influence their respiratory health. An important feature of this exposure is that it begins early in life. In Norway and many other western countries, most children spend several years in day care centers. Even a small increase in disease risk because of day care centers has important public health consequences. There is evidence that attendance to day care centers during the first 3 years of life increases the risk of respiratory and gastrointestinal infections.^{11–19} Some studies have indicated that long-term day care center attendance leads to a diminished risk of infections,¹⁵ and that experience of early infections might protect from the development of asthma and atopy later in life.^{20–22}

The Oslo Day Care Environment and Children's Health project was initiated to assess the characteristics of the day care environment as determinants of children's respiratory health. The present study elaborates the effects of day care outside the home on respiratory health with a special emphasis on the age when starting the day care center attendance.

METHODS

Study Population and Data Collection

The source population included all 6364 children who, according to the Norwegian Population Registry, were born in 1992 and were official residents in the city of Oslo in November 1996. Children of non-Norwegian parents ($n = 1398$) were excluded because of expected language difficulties in providing information by a self-administered questionnaire. A home address was identified for 4863 of the 4966 families, fulfilling the inclusion criteria (98%). These families received a self-administered questionnaire with a preaddressed return envelope in November and December 1996. Most of the children were at that time between 4 and 5 years of age. The study population consisted of 3853 children, whose parents returned a completed questionnaire (response rate, 79%). The questionnaire included questions on day care arrangements, children's health, environmental conditions, and family characteristics.

Children who had started in a day care center because of an illness ($n = 98$) were excluded from the analyses together with 6 children with no information on day care practice. This left 3749 children for the current analyses.

Health Outcomes

The main health outcomes were respiratory symptoms includ-

Effects of environmental exposures on respiratory and allergic conditions have received worldwide attention. The adverse health effects of some of the exposures such as environmental tobacco smoke, dampness, house dust mites, pres-

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wheeze, heavy breathing or chest tightness, and respiratory infections including the common cold, tonsillitis/pharyngitis, otitis media, bronchitis, and pneumonia. The occurrence of the symptoms and infections during the previous 4 weeks and 12 months was requested. The parents were asked to indicate the frequency of symptoms (daily, 1–3 days per week, 1–3 days per month, or <1 day per month) and to recall the number of infections during the previous 12 months. Frequency of symptoms was dichotomized into symptom variables (1, symptoms at least 1 day per month; 0, <1 day per month). In addition, the parents were asked to report whether the child ever had experienced recurrent otitis media or croup (more than three episodes within a year), and whether the child ever had been diagnosed by a doctor as having asthma or hay fever (including other allergies with upper respiratory symptoms). They were also asked to specify whether the child had experienced symptoms of asthma or hay fever during the past 12 months.

Type of Day Care

The type of day care was divided into the following three categories: 1) home care (at home with mother or father, at home with a nursing assistant, or at home but attending organized play grounds together with other children), 2) family day care (in a family or private nursery outside the home), and 3) day care center (owned by the municipality or privately owned). The parents were, in the questionnaire, asked about their child's current day care arrangement and day care arrangements during the child's first, second, third, and fourth years of life. In this study, we have focused on current day care arrangements and starting time in day care centers. Families reporting several current day care arrangements for their child ($n = 264$) or giving incomplete information on current day care arrangements ($n = 40$) were categorized in a separate combined category. As some of the children had not reached the age of 4 years at the time the questionnaire was filled in, day care arrangements between 3 and 4 years of age were used in case of missing information on current day care arrangements.

The starting age in the day care center was defined as the age when the child first attended a day care center. The information was divided into four categories, ie, 0 to <2 years, 2 to <3 years, ≥ 3 years, and never. The youngest age category covered a relatively long time period, because only few children in Norway attend day care centers before the age of 1 year (2% in this population). Information on the number of children in the day care centers together with the child and the number of hours per week currently spent in the day care center were collected, as well as whether a health problem was the reason for attending day care.

Covariates

Information on sex, birth weight, duration of breastfeeding, siblings, maternal and paternal education, one or two parent family, maternal and paternal smoking, pets (cats and dogs), home dampness problems, and maternal and paternal asthma was extracted from the questionnaire. The covariates and their distributions according to the current day care practice are listed in Table 1. Families indicating at least one of the seven listed signs of dampness problems in their home during the past 12 months were categorized as having a dampness problem.

Statistical Methods

The relation between the occurrence of health outcomes and day care center attendance was assessed by crude and adjusted odds ratios. Logistic regression analysis was applied for the adjustment. Adjusted incidence rate ratios were estimated by means of Poisson regression for the common cold and otitis media episodes. Missing values in the covariates were given a separate value and the analyses were performed with and without missing data. Both approaches gave similar results and only results of models including strata with missing values are presented. Attributable proportions (AP) of respiratory infections because of day care centers with home care as the reference were calculated by using adjusted incidence rate ratios (IR): $AP = (IR - 1)/IR$.²³ The attributable proportion of disease in the total population (AP_t) was also estimated by considering the proportion of children attending day care centers (P_c), $AP_t = AP \times P_c$. The analyses were performed by using SPSS for Windows, Version 6.1.²⁴

RESULTS

Day Care Arrangement in Oslo

Of the participating children, 10% were in home care, 2% in private homes, 80% in day care centers, and 8% had combined day care arrangements (several day care arrangements or incomplete information) at the time the data were collected (Table 1). Table 1 also shows the distribution of child and family characteristics according to the current day care practice. Day care center children had, on average, better-educated parents, fewer siblings, and more often a single parent compared with children in home care. Most of the day care center children spent >25 hours per week at the center (87%) (missing

TABLE 1. Child and Family Characteristics Among 3749 Preschool Children in Oslo, Norway, According to Day Care Arrangements

	Home Care, % ($n = 384$)	Family Day Care, % ($n = 77$)	Day Care Center, % ($n = 2984$)	Combined, % ($n = 304$)	Total, % ($n = 3749$)
Boy	50	60	50	57	51
Birth weight (≤ 2500 g)	5	3	5	7	5
Breastfeeding (<4 months)	17	13	14	16	14
Siblings (yes)	94	59	78	90	80
Maternal education					
<12 years	15	9	6	13	7
12–15 years	72	73	65	67	66
>15 years	13	18	30	20	27
Paternal education					
<12 years	19	14	9	14	10
12–15 years	59	62	56	56	56
>15 years	22	23	36	30	34
One-parent family	11	9	18	15	17
Maternal smoking during previous 12 months	30	37	33	29	32
Paternal smoking during previous 12 months	31	34	31	28	31
Pets					
Ever exposed to dog	15	11	15	14	14
Ever exposed to cat	14	16	12	11	13
Home dampness problem last year	15	16	15	16	16
Maternal asthma	9	7	9	11	9
Paternal asthma	7	5	7	10	8

Missing information: birth weight, 241; breastfeeding, 213; siblings, 257; maternal education, 31; paternal education, 143; one-parent family, 7; maternal smoking, 105; paternal smoking, 264; pets, 173; maternal asthma, 69; paternal asthma, 110.

information, 255 children), and a majority (57%) attended centers with >16 other children (missing information, 222 children). Only a small proportion (1.9%) was with <10 other children.

Type of Day Care and Health

Table 2 presents the occurrence of respiratory symptoms and diseases according to current day care arrangements. The prevalence of all respiratory symptoms during the past 12 months was larger among children in day care centers compared with children in home care. The difference in nightly cough (19% vs 11%) and nasal symptoms (14% vs 9%) was substantial. Children in day care centers experienced more often at least one episode of otitis media compared with children in home care (26% vs 19%). Most children had suffered from at least one episode of common cold. Even so, the proportion was higher among children attending a day care center than among children in home care (92% vs 87%). The same was also true for the common cold during the previous month (60% vs 49%). Episodes of otitis media and common cold during the last year were not substantially more common among children in day care centers with >16 children than among children in day care centers with ≤16 children (27% vs 24% and 93% vs 92%). This was also the case for the other outcomes. The mean number of common colds during the past year was higher among children in day care centers (2.9; SE, 0.04) compared with children in home care (2.4; SE, 0.09). The corresponding values for otitis media were 0.44 (SE, 0.02) and 0.31 (SE, 0.04). In Poisson regression, controlling for confounding, the incidence rate ratios for common cold and otitis media were 1.21 (95% confidence interval, 1.12–1.30) and 1.48 (95% confidence interval, 1.22–1.80) in children in day care centers compared with children in home care. The occurrence of lower respiratory tract symptoms such as wheezing and heavy breathing or chest tightness, lower respiratory tract infections, and allergic diseases during the past 12 months was similar between the day care center and home-care children. The

results of the logistic regression analysis, controlling for confounding, corresponded in general with the crude analysis (Table 3). The prevalences of respiratory symptoms and diseases during the past year in children who had stayed in a day care center ever since their second year of life ($n = 719$) were similar to those for children currently in day care centers (data not given). In day care center children, the attributable proportion of disease because of type of day care was 17.4% (95% confidence interval, 10.7–23.1) for common cold and 32.4% (18.0–44.4) for otitis media. The corresponding attributable proportions calculated for the total population were 13.9% (8.6–18.5) and 25.9% (14.4–35.5).

Effects of Starting Age

The percentages of children who had ever experienced recurrent otitis media, recurrent croup, or ever had doctor-diagnosed asthma or hay fever are presented in Table 4. The occurrence of recurrent otitis media (13.5% vs 8.1%), recurrent croup (4.5% vs 2.8%), and doctor-diagnosed asthma (9.3% vs 8.6%) was higher in children who sometimes had attended a day care center compared with those who had not. Without considering the duration of the day care center attendance, the risk of recurrent otitis media was strongly related to the starting age with a decreasing trend in the risk the higher the age in attendance (0–2 years, 17.5%; 2–3 years, 12.4%; ≥3 years, 11.0%; and never, 8.1%) (Table 4). The lifetime risk of doctor-diagnosed asthma was related to the starting age of 0 to 2 years (0–2 years, 11.7%; 2–3 years, 8.8%; ≥3 years, 8.1%; and never, 8.6%).

DISCUSSION

In our population-based cross-sectional study, the 3- to 5-year-old children in day care centers experienced more upper respiratory symptoms and infections compared with children in home care. Approximately 14% of the common cold episodes and 26% of the acute otitis media episodes in this population were estimated to be attributable to day care center attendance. The occurrence of lower respiratory tract

TABLE 2. The Percentage of Preschool Children in Oslo With Respiratory Symptoms (At Least 1 Day per Month) and Diseases During the Previous 12 Months According to Day Care Arrangements

	Home Care, % ($n = 384$)	Family Day Care, % ($n = 77$)	Day Care Center, % ($n = 2984$)	Combined, % ($n = 304$)	Total, % ($n = 3749$)
Respiratory symptoms					
Cough during the night	11	16	19	18	18
Blocked or runny nose without common cold	9	9	14	13	14
Wheeze	3	4	4	3	4
Heavy breathing or chest tightness	5	5	7	7	7
Respiratory infections					
Common cold	87	92	92	93	92
Pharyngitis or tonsillitis	21	25	21	18	21
Otitis media	19	33	26	24	25
Bronchitis	7	7	6	7	6
Pneumonia	3	4	4	4	4
Allergy*					
Asthma	6	4	6	8	6
Hay fever†	4	1	4	5	4

Note: Information on various health outcomes in 33 to 85 cases is missing.

* Doctor diagnosis of asthma or hay fever and presence of symptoms during the previous 12 months.

† Symptoms of allergy from the eyes or upper respiratory organs.

TABLE 3. Crude (cOR) and Adjusted (aOR) Odds Ratios With 95% Confidence Intervals (CI) for Respiratory Symptoms (At Least 1 Day per Month) and Diseases During the Previous 12 Months Among Preschool Children in Day Care Centers Versus in Home Care (Reference Category)

	cOR	95% CI	aOR	95% CI
Respiratory symptoms				
Cough during the night	1.82	1.31-2.53	1.89	1.34-2.67
Blocked or runny nose without common cold	1.63	1.13-2.34	1.55	1.07-1.61
Wheeze	1.00	0.56-1.81	1.19	0.64-2.22
Heavy breathing or chest tightness	1.42	0.89-2.27	1.50	0.92-2.45
Respiratory infections				
Common cold	1.73	1.24-2.41	1.64	1.15-2.32
Pharyngitis or tonsillitis	0.96	0.74-1.25	0.95	0.73-1.25
Otitis media	1.52	1.16-1.98	1.54	1.16-2.03
Bronchitis	0.85	0.55-1.32	0.90	0.57-1.41
Pneumonia	1.47	0.76-2.83	1.34	0.69-2.68
Allergy*				
Asthma	1.08	0.68-1.72	1.16	0.71-1.89
Hay fever†	1.07	0.59-1.91	1.39	0.76-2.57

The adjusted odds ratios are controlled for sex, birth weight, duration of breastfeeding, siblings, maternal and paternal education, one- or two-parent family, maternal and paternal smoking, pets (cats and dogs), home dampness problems, and maternal and paternal asthma.

* Doctor diagnosis of asthma or hay fever and presence of symptoms during the previous 12 months.

† Symptoms of allergy from the eyes or upper respiratory organs.

TABLE 4. Occurrence of Doctor-Diagnosed Asthma and Hay Fever*, and Recurrent Otitis Media and Croup in Preschool Children According to Starting Age in Day Care Center and the Adjusted Odds Ratios (aOR) for These Diseases Contrasted to Never in Day Care Centers

	Never in Day Care Center (n = 517)	Starting Age in Day Care Center			Total (n = 3749)
		3 Years or More (n = 1349)	2 to 3 Years (n = 830)	0 to 2 Years (n = 1043)	
Asthma					
%	8.6	8.1	8.8	11.7	9.3
aOR	1 (ref)	1.01	1.16	1.59	
95% CI		(0.68-1.49)	(0.76-1.77)	(1.07-2.36)	
Hay fever*					
%	6.5	4.3	4.8	4.4	4.7
aOR	1 (ref)	0.78	0.95	0.83	
95% CI		(0.49-12.3)	(0.57-1.58)	(0.51-1.37)	
Recurrent otitis media					
%	8.1	11.0	12.4	17.5	12.7
aOR	1 (ref)	1.48	1.73	2.60	
95% CI		(1.02-2.14)	(1.17-2.56)	(1.80-3.77)	
Recurrent croup					
%	2.8	4.2	4.8	4.5	4.3
aOR	1 (ref)	1.66	1.91	1.76	
95% CI		(0.91-3.05)	(1.01-3.63)	(0.94-3.29)	

Missing information in 33-85 cases. The adjusted odds ratios are controlled for sex, birth weight, duration of breastfeeding, siblings, maternal and paternal education, one- or two-parent family, maternal and paternal smoking, pets (cats and dogs), home dampness problems, and maternal and paternal asthma.

* Symptoms of allergy from the eyes or upper respiratory organs.

CI, confidence interval.

symptoms (wheezing and heavy breathing or chest tightness) and infections as well as allergic diseases did not differ substantially between the compared groups. The risk of recurrent otitis media was higher the lower the starting age in the day care center, whereas lifetime risk of doctor-diagnosed asthma was increased in children starting at the day care centers during the first 2 years of life. Because of long maternity leave, almost all Norwegian children are cared for at home during their first year of life. The health effects of starting age in day care centers during the first year of life could therefore not be studied.

Validity of Results

Our objective was to evaluate whether day care center attendance causes respiratory health effects in

preschool children. The causal inference was based on outcome and exposure information collected concurrently from the same source, the parents or guardians of the children. There are two possible mechanisms of how selection of the study population could introduce a bias. The health of children taken to day care outside the home could be different from the health of children in home care, most likely so that more healthy children are likely to be taken to day care centers. The children in day care centers with most respiratory problems are likely to be taken back to home care as a preventive measure. These two suggested mechanisms of selection would both lead to underestimation of the relation between disease occurrence and care in day care centers. The use of the starting age in the day care center could eliminate the latter type of selection bias.

Parents of children in day care centers have to organize alternative day care arrangements in case these children get ill. This could increase awareness and reporting of illnesses compared with parents of children in home care. If so, this would probably have affected the reporting of most symptoms and illnesses and not only for the upper respiratory problems.

Most of the known potential confounders were taken into account in the logistic and Poisson regression analyses.

Synthesis With the Previous Knowledge

Our observation of the association between the occurrence of respiratory symptoms and infections and care in day care centers is consistent with the results from recent studies.¹¹⁻¹⁸ Most of these studies have focused on younger age groups. In the studies including also older children, the effect of day care center attendance on respiratory diseases disappeared or became weaker in the older children.^{12,15,18} In the present study, the occurrence of otitis media, common cold, nightly cough, and nasal symptoms were related to care in day care centers in 3- to 5-year-old children. In a Finnish population-based study,¹² day care center attendance had an effect on otitis media in 4-year-old children (incidence rate ratio, 1.65). An effect on common cold was seen in younger children, but no more in 4-year-old children. In the present study, lower respiratory tract infections were not increased in children attending day care centers. Day care center attendance possibly increases the exposure to pathogens causing upper respiratory tract infections, and children of 3 to 5 years have an increased risk of being affected by such exposure. Lower respiratory infections are in general less common at this age than in younger children, possibly because of increased resistance, and the present study indicates that day care center attendance does not increase the risk of these infections.

At least one previous study indicated that long-term day care attendance leads to a decreased risk of respiratory infections.¹⁵ The results of the present study are inconsistent with a hypothesis of a protective effect. Children in day care centers ever since their second year of life had the same prevalence of respiratory symptoms as those currently in day care centers and, thus, higher than in children in home care.

The occurrence of respiratory problems did not show any clear relation to the number of children in the day care centers. However, few children attended a small day care center. It could be that the day care center practice in the study population did not vary enough to properly explore the effect of numbers of children in day care centers.

The effects of day care center attendance on the risk of common cold and otitis media were substantial. The risk of recurrent otitis media was strongly associated with the starting age in the day care center. This finding is consistent with the previous observation that the effect of day care center attendance on otitis media is strongest in young children.^{12,18}

In the present study, the occurrence of doctor-diagnosed asthma and symptoms of asthma during the past 12 months, including wheezing and heavy breathing or chest tightness, were not related to the type of day care. However, the lifetime risk of doctor-diagnosed asthma was related to an early starting age in a day care center. There is increasing evidence that day care center attendance increases the risk of both upper and lower respiratory tract infections in particular in the youngest children (<3 years old). The effect of early starting age on asthma could be mediated by this increased risk of respiratory infections, and thus experience of early respiratory infections would increase rather than decrease the risk of asthma later in life. It is also possible that repeated infections increase the risk of receiving a diagnosis of asthma independent from actual asthma, which is difficult to diagnose with any objective measure in this age period. The lack of association between asthma occurrence and current type of day care could be a result of selection of children with asthma or asthma-like symptoms from day care centers to home care.

CONCLUSIONS

The results are consistent with the hypothesis that day care center attendance increases the risk of upper respiratory symptoms and diseases also in 3- to 5-year-old children and that long-term stay in day care center does not protect against these effects. Starting age in day care outside home seems to be of importance for recurrent otitis media as well as asthma. The effect of day care center attendance on asthma is limited to early age up to 2 years. This effect is most likely mediated via early respiratory tract infections that are substantially more common in children in day care centers compared with children in home care. Thus, these findings do not support the hypothesis that early respiratory infections protect against development of asthma.

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