

Original article

Day-care attendance and increased risk for respiratory and allergic symptoms in preschool age

Background: The reported impact of day-care attendance on respiratory and atopic symptoms has varied between studies from different countries. Regarding to the 'hygiene-hypothesis', day-care attendance may lead to less sensitization later in life, but the question still is whether day-care attendance and subsequent exposure to more frequent early infections is a risk or a protection against future allergic disease or asthma (atopic and nonatopic).

Methods: A cross-sectional postal questionnaire was replied by parents of 10 851 children, aged 1–6 years, in the year 2000 in a Swedish region (DBH-phase 1). The questionnaire focused on respiratory and atopic symptoms, the home environment and information on day care of the children.

Results: Children in day care were reported to have more symptoms than children in home care: adjusted odds ratio (AOR) for wheezing last 12 months, AOR 1.33 (CI 95%: 1.12–1.58), cough at night apart from colds last 12 months AOR 1.56 (CI: 1.17–2.07), doctor diagnosed asthma AOR 1.23 (CI: 0.88–1.71), rhinitis last 12 months AOR 1.15 (CI: 0.92–1.44), doctor diagnosed hay fever AOR 1.75 (CI: 0.94–3.23), eczema last 12 months, AOR 1.49 (CI: 1.24–1.79), allergic reactions to foods, AOR 1.27 (CI: 1.07–1.52), > 6 colds last 12 months of 2.57 (CI: 2.12–3.12) and ear infection ever AOR 2.14 (CI: 1.87–2.45). The increased risks were mainly seen and reached significance in the youngest group of children, aged 1–4 years. Adjusting and stratification for the number of airway infections last year did not change the risk associated with day-care attendance for allergic diseases.

Conclusions: Attending day care was associated with an increased risk of symptoms related to airways infections as well with eczema and allergic reactions to food. No sign of protection from day-care attendance for allergic diseases was found up to 6 years of age. Multiple airway infections and day-care attendance were found to be independently associated with asthma and allergic symptoms.

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The prevalence of asthma and allergy has increased over the past decades in Sweden as in the entire Western world (1, 2). Numerous factors have been associated to an increased prevalence, such as urban living, exposure to tobacco smoke, lack of microbiological exposure and living in a home with mould and dampness. Dose response associations have been shown between home ventilation rates, and exposure to phthalates in dust and allergic diseases (3, 4). None of these, however, have been convincingly shown as the basal factor underlying the 'allergy epidemic' (2, 5, 6).

Early childhood infections have been proposed to protect against allergic diseases, 'the hygiene hypothesis' (7). Attendance at a day-care centre involves a high exposure to infections and, in some studies, also a protection against later asthma and hay fever, particularly in children with few siblings (7–10). During the first years of

life, however, children attending day care have an increased morbidity in airways infections and respiratory symptoms compared with children that stay at home (11–13).

The starting age in public day care varies between different countries. In Sweden, most children stay at home until about 18 months of age. In this paper, the aim is to analyse the impact of current day-care attendance, and age when starting at day-care centres on respiratory and allergic diseases in a total population of children aged 1–6 years in a Swedish region.

Method

Study population

This study is part of a multidisciplinary survey on indoor environment in homes and health effects among preschool children, called

Dampness in Buildings and Health (DBH) (14). A questionnaire with 84 questions was sent out in March 2000 to all families with children between 1 and 6 years of age in the county of Värmland in Sweden (DBH-phase 1). Of 14 077 mailed questionnaires, 100 were used in a pilot study and 195 could not be reached by post, and a response rate of 79%, yielded 10 851 included children. A nonrespondent analysis was performed to investigate possible selection biases. Of 200 nonrespondent families, 166 were reached by telephone. There were no significant differences in reports of symptoms, type of dwelling, or reports of dampness, between responding and nonresponding families (15).

Questions on allergic symptoms were the same as used in the ISAAC questionnaire (16). The following symptom reports were studied: wheezing, cough at night apart from cold, rhinitis symptoms apart from cold (sneezing, runny nose or congestion), itching eczema and the number of colds, all for the last 12 months; doctor diagnosed asthma and hay fever, ever any allergic reactions to any food and ever any ear infection.

The questions about day care included current type of day care (day-care centre, family day care), time spent there (<20 h/week and 20 h/week or more) and age when the child started. Family day care in Sweden means that the child is in a private home together with three to six children. Information on the child's starting age at day care was only obtained from children attending day-care centres and not family day care.

Statistics

Associations between day-care status, symptoms and covariates were first tested with chi-square test. Background information interfering with day-care status was used as adjustment variables in multiple logistic regression analyses. Logistic regression analyses were used to calculate crude and adjusted odds ratio (AOR) with 95% confidence interval. Statistical analyses have been made in SPSS 11.05. Adjustments have been made for: gender (male vs female), age (1–3 years of age vs 3–6 years of age), breastfeeding, full or partial (<3 months vs 3 months or more), siblings (one or more siblings vs no siblings), current smoking mother or father (yes vs no), atopic parent (asthma, allergic disease from nose or eyes or eczema vs no such symptoms among mother or father), single parenthood (one adult over 18 years of age living in the home vs two or more adults), furred pets at home vs no furred pet, living in the centre of the town (urban), outside in a housing area (suburban) or in the countryside (rural) and type of house (single family house or chain house vs apartment in a multi-family house). Additionally, adjustments were moreover made for airway infections in some analyses.

Ethics

The study was approved by the Ethics Committee in Örebro, Sweden.

Results

Attending day care was common in the investigated population of children 1–6 years of age since 87.2% of the children were in current day care or had attended day care earlier in life, Table 1. In the youngest group of children, aged 1–2 years, 71.2% were currently or had earlier been in day care while the corresponding frequency for the older children aged 5–6 years, was 92.6%.

Table 1. Different type of day care in relation to age of the child

	Type of day care, <i>n</i> (%)				
	Home care	Day care >20 h/week	Day care <20 h/week	Family day care	Earlier day care but not now
1–2 years	578 (28.8)	736 (36.7)	293 (14.6)	359 (17.9)	39 (1.9)
2–3 years	274 (13.8)	858 (43.2)	337 (17.0)	338 (17.0)	181 (9.1)
3–4 years	195 (9.3)	947 (45.3)	367 (17.6)	397 (19.0)	183 (8.8)
4–5 years	150 (6.6)	1148 (50.7)	368 (16.3)	405 (17.9)	192 (8.5)
5–6 years	178 (7.4)	1217 (50.7)	435 (18.1)	403 (16.8)	166 (6.9)
Total	1375 (12.8)	4906 (45.7)	1800 (16.8)	1902 (17.7)	761 (7.1)

Table 2 gives demographic characteristics for different type of day-care attendance. Children cared at home were younger, had more often one or more siblings, lived more often in a rural area, in single-family houses and had more often furred pets at home compared with children attending day care. Furthermore, they less often lived with a single parent and less often had a parent with atopic disease. To start at a day-care centre before 1 year of age was uncommon (4.9%). Children with such an early start at day-care centre were more likely to be breast fed <3 months, having no siblings, a smoking parent, living together with one single parent, living in urban or suburban region, and in a multi-family house or chain house. The variables (about family and exposures) listed in Table 2 are known to be associated with symptoms of asthma, allergy and infections. As they also correlate to various aspects of day care they were used as adjustment variables in the multiple logistic regression analyses.

In Table 3, the association between symptoms in different types of day care is presented with their AOR for day care compared with home care. In crude analyses, all the listed symptoms were positively more frequently found for children at day care compared with at home care. Respiratory symptoms such as wheeze, nightly cough, multiple colds and ear infection were in the adjusted analyses significantly associated with day-care attendance as well as allergic reactions to foodstuffs and eczema. Doctor diagnosed asthma were more associated to family day care, and with having earlier attended day care.

The risks of symptoms were more or less similar between the groups of children irregardless of the time spent at the day-care centre (>20 h/week vs <20 h/week), except for eczema last 12 months (21.2 vs 18.7%; χ^2 -test: $P = 0.024$) and having more than six colds (21.5 vs 19.3%; $P = 0.050$).

When stratifying for age (1–4 and 4–6 years) all symptoms were more common among children in day care compared with home care. However, significant results were mainly found in the younger group of children (wheezing, cough at night, reactions to foods, multiple colds and ear infections) in adjusted analyses. Among the older children (4–6 years old), a significant difference in symptoms between home care and day-care

Table 2. Different type of day care in relation to demographic characteristics

Characteristics	Type of day care, <i>n</i> (%)						If day-care centre, age for starting, <i>n</i> (%)			
	Home care	Day-care centre >20 h/week	Day-care centre <20 h/week	Family day care	Earlier day care but not now	<i>P</i> -value*	Before 1 year of age	1–2 years	After 2 years of age	<i>P</i> -value†
Total study population, <i>n</i>	1375 (12.8)	4906 (45.7)	1800 (16.8)	1902 (17.7)	761 (7.1)		363 (4.9)	5601 (75.6)	13.3 (19.5)	
No breastfeeding or <3 months	215 (15.7)	712 (14.6)	283 (15.9)	286 (15.1)	109 (14.5)	0.430	19.9	14.3	16.2	0.008
Sibling (one or more)	1101 (80.6)	3768 (77.7)	1413 (79.2)	1420 (75.4)	704 (92.6)	0.394	72.9	78.4	85.6	0.004
Smoking mother or father	307 (22.3)	1104 (22.5)	481 (26.7)	517 (27.2)	174 (22.9)	0.322	36.4	22.0	25.9	<0.001
Atopic parent	604 (43.9)	2360 (48.1)	865 (47.5)	904 (43.6)	332 (43.9)	0.011	49.6	48.4	44.7	0.423
Single parenthood	57 (4.2)	588 (12.2)	141 (7.9)	199 (10.6)	32 (4.2)	<0.001	16.5	9.8	11.0	<0.001
Rural	680 (50.1)	1268 (26.4)	581 (32.9)	820 (44.0)	278 (36.8)	<0.001	20.4	28.1	34.5	<0.001
Sub-urban	576 (42.4)	2884 (59.9)	977 (55.4)	884 (47.4)	412 (56.6)	<0.001	63.7	59.5	52.8	0.020
Urban	80 (5.9)	543 (11.3)	162 (9.2)	107 (5.7)	52 (6.9)	<0.001	15.0	9.9	10.5	0.001
Single family houses (SH)	1087 (81.2)	3295 (68.9)	1262 (72.0)	1466 (79.0)	602 (80.4)	<0.001	48.0	70.7	72.3	<0.001
Chain houses (CH)	82 (6.1)	502 (10.5)	154 (8.8)	131 (7.1)	131 (8.7)	<0.001	14.0	9.8	8.7	0.006
Multi family houses (MH)	170 (12.7)	984 (20.6)	337 (19.2)	259 (14.0)	82 (10.9)	<0.001	37.2	18.1	17.8	<0.001
Furred pet at home	681 (49.5)	1665 (33.9)	719 (39.9)	929 (48.8)	337 (44.3)	<0.001	34.4	35.2	41.4	0.287

*Chi-square test; home care vs day-care centre (>20 h/week and <20 h/week).

†Chi-square test; before 1 year of age vs later start (1–2 year and after 2 years of age).

Table 3. Prevalence of symptoms in different day care and association between different day care and symptoms expressed adjusted odds ratio including 95% confidence interval

Symptoms	Home care (reference)		Day care >20 h/week		Day care <20 h/week		Family day care		Earlier day care but not now	
	%	AOR (reference)	%	AOR* (95% CI)	%	AOR* (95% CI)	%	AOR* (95% CI)	%	AOR* (95% CI)
Wheezing last 12 months	17.1	1.0	19.6	1.33 (1.12–1.58)	20.6	1.41 (1.16–1.71)	20.5	1.37 (1.13–1.67)	16.1	1.10 (0.85–1.42)
Cough at night last 12 months (>2 weeks)	4.9	1.0	8.3	1.56 (1.17–2.07)	8.2	1.61 (1.17–2.20)	7.1	1.51 (1.10–2.07)	6.1	1.21 (0.80–1.83)
Asthma diagnosed by doctor	3.7	1.0	5.4	1.23 (0.88–1.71)	5.5	1.33 (0.92–1.92)	6.4	1.70 (1.19–2.44)	6.1	1.61 (1.04–2.48)
Rhinitis last 12 months	8.5	1.0	12.1	1.15 (0.92–1.44)	11.4	1.17 (0.91–1.51)	11.5	1.22 (0.95–1.57)	10.7	1.24 (0.90–1.71)
Hay fever diagnosed by doctor	0.9	1.0	2.5	1.75 (0.94–3.23)	2.6	1.72 (0.89–3.35)	2.3	1.81 (0.94–3.51)	1.8	1.21 (0.52–2.78)
Eczema last 12 months	13.2	1.0	21.2	1.49 (1.24–1.79)	18.7	1.33 (1.07–1.64)	16.8	1.21 (0.98–1.49)	18.5	1.37 (1.06–1.77)
Allergic reactions of food	15.5	1.0	21.0	1.27 (1.07–1.52)	20.3	1.22 (1.00–1.49) 1	18.4	1.10 (0.90–1.34)	17.3	1.13 (0.88–1.45)
More than six colds last 12 months	11.5	1.0	21.5	2.57 (2.12–3.12)	19.3	2.32 (1.87–2.88)	15.6	1.74 (1.40–2.17)	13.2	1.61 (1.21–2.14)
Ear infection ever	42.4	1.0	64.7	2.14 (1.87–2.45)	62.5	1.95 (1.68–2.28)	57.8	1.70 (1.46–1.97)	60.5	1.78 (1.47–2.16)

*Adjusted odds ratio (AOR), adjusted for gender, age, siblings, smoking parent, atopic parent, single parenthood, furred pet, breastfeeding <3 months, type of house, urbanity.

centre attendance was seen in crude analyses for rhinitis last year, doctor diagnosed hay fever, eczema last year, allergic reactions to food and ear infection, while ear infection was the only disease that reached significance in the adjusted analyses (Table 4).

Of 7406 children (61 missing information on age for starting), 363 (4.9%) started at the day-care centre before 1 year of age, 5601 (75.6%) started between 1 and 2 years of age and 1442 (19.5%) started after 2 years of age (Table 5). Wheezing, cough at night, rhinitis, eczema and allergic reactions to food were more prevalent among children entering day-care centre during the first year of life compared with later entrance. On the contrary, children starting at a day-care centre after 2 years of age had a higher risk of doctor diagnosed asthma and hay fever compared with children who started earlier.

We found a strong co-variation of the prevalence of asthma and allergic symptoms and the number of reported colds last 12 months. The association was more pronounced for respiratory symptoms than for atopy-related symptoms, data not shown. To evaluate if the associations between day-care attendance and health symptoms can be explained by more common cold infections among children in day care, we both adjusted and stratified the data. When adjusting for the number of colds last year (< 6, 6–10 or > 10 colds) together with the other adjustment variables in Table 3, AORs for day-care attendance and for starting age at day-care centre (Table 5) remained roughly the same. In stratified analyses, the association between day care and symptoms were stronger in the group of children with less than six colds last year than among children with more colds last

Table 4. Association between symptoms and day care in different age groups expressed as adjusted odds ratios

	Age 1–4 years				Age 4–6 years			
	Home care, <i>n</i> (%)	Day care, <i>n</i> (%)	<i>P</i> -value*	AOR† 95% CI	Home care, <i>n</i> (%)	Day care, <i>n</i> (%)	<i>P</i> -value	AOR† 95% CI
Wheezing last 12 months	186 (18.1)	836 (24.1)	<0.01	1.47 (1.22–1.78)	46 (14.1)	465 (15.0)	0.65	1.03 (0.72–1.47)
Cough at night last 12 months (>2 weeks)	49 (4.7)	318 (9.1)	<0.01	1.82 (1.31–2.52)	17 (5.2)	228 (7.3)	0.17	0.97 (0.57–1.64)
Asthma diagnosed by doctor	34 (3.3)	185 (5.3)	0.01	1.46 (0.99–2.16)	16 (4.9)	172 (5.5)	0.65	1.02 (0.56–1.86)
Rhinitis last 12 months	95 (9.2)	434 (12.5)	<0.01	1.09 (0.85–1.41)	20 (6.2)	351 (11.3)	0.01	1.32 (0.81–2.15)
Hay fever diagnosed by doctor	7 (0.7)	55 (1.6)	0.03	1.61 (0.71–3.65)	5 (1.5)	111 (3.5)	0.05	1.71 (0.68–4.32)
Eczema last 12 months	139 (13.3)	733 (20.7)	<0.01	1.44 (1.17–1.78)	42 (12.8)	642 (20.3)	<0.01	1.32 (0.92–1.89)
Allergic reactions of food	166 (16.0)	753 (21.5)	<0.01	1.29 (1.06–1.57)	45 (13.8)	627 (20.0)	0.01	1.28 (0.90–1.81)
More than six colds last 12 months	129 (12.4)	1019 (29.1)	<0.01	3.03 (2.46–3.74)	28 (8.6)	367 (11.7)	0.09	1.22 (0.80–1.88)
Ear infection ever	401 (38.5)	2086 (59.3)	<0.01	2.24 (1.92–2.61)	179 (54.9)	2179 (64.9)	<0.01	1.71 (1.33–2.19)

*Pearson chi-square for home care vs day-care centre attendance.

†Adjusted odds ratio (AOR), adjusted for gender, siblings, smoking parent, atopic parent, single parenthood, furred pet, breastfeeding <3 months, type of house, urbanity.

year. However, in the group of children with > 10 colds (total *n* = 151, home care *n* = 16), the prevalence of symptoms were higher for children in day care but this difference was not significant for any symptom.

Discussion

The strength of the present study includes a large sample size and a population based design. The sample size allow statistical models with adjustment for covariates such as gender, age, smoking parent, single parenthood, atopic parent, furred pet at home, breastfeeding, type of dwelling, urbanity and reported dampness at home. The high response rate and the nonresponder analysis (15) indicate that the results are highly representative for this region in Sweden.

Information on type of day care was collected for the current situation. The questionnaire focused mainly on allergic and asthmatic symptoms during the last 12 months. Parental report of ear infection ever, doctor diagnosed hay fever and asthma and allergic reactions to food should be reliable if collected within the first few years of the life of the children. In most instances, only clinically insignificant rash after some foods may have been forgotten. One may argue that parents to children in day care may remember colds or long-lasting nightly cough of their child if their work was disrupted compared with parents who always are at home. However, the main part of the health variables may not be affected by this recollection bias, particularly considering the relatively short recollection time interval (12 months). In addition, many of the included symptoms would probably not give rise to disruption of work for parents with children in day care, e.g. doctor diagnosed hay fever or asthma, eczema or reactions of food resulting in limited risk for recollection bias.

There is a risk of bias if parents to sensitive children actively behave different, like choosing a family day care

instead of day-care centre or chose to stay at home to care their child for a longer time (late start at day care or home care) to minimize the infection exposure. Children in family day care and children who earlier had attended day care had a higher prevalence of asthma (7.4% and 6.1%) than children attending day-care centres (5.5%) currently. This could be an indication of that parents to children with severe asthma more often choose to quit day-care centre care and/or change to family day care. Our findings on a late start (after 2 years of age) at day-care centre as a risk factor for hay fever and asthma may be also a result of such a behaviour. Some parents of children with asthma or other diseases may choose to stay at home during the whole preschool time. It has, however, not been possible to identify such families in this data set and such behaviour cannot explain our results, rather the opposite. In some places in Sweden, allergic and asthmatic children with severe disease have access to special 'allergy day-care centres' where higher demands on hygiene, 'no pets' and infections among the children are taken into account. The number of children attending such centres is, however, so low that it can only marginally affect the results.

There is a general agreement that symptoms of colds and complications in terms of both wheezing and ear infections in small children increases with exposure to other children in day-care settings (13, 17–20). In the present study, there were significantly higher frequencies of the number of respiratory symptoms, infections and allergic disease among children who attended day care than among children in home care. While wheezing is more readily related to airway infections, the increased occurrence of eczema and food allergy is not expected (21, 22).

Our findings of an increased prevalence of atopic symptoms among children in day-care centres could not be explained by a co-variation with multiple colds. The prevalence of the many symptoms and diagnoses were in general increased with the number of colds. However, the

Table 5. Association between age for starting at day care and symptoms among children aged 1–6 years

Outcome	Home care (reference), n = 1375			Day-care centre attendance						P trend†			
	Start before 1 year of age, n = 363			Start at 1–2 years of age, n = 5601			Start after 2 years of age, n = 1442						
	%	OR		%	OR (95% CI)	AOR (95% CI)*	%	OR (95% CI)	AOR (95% CI)*				
Outcome	%	OR		% <td>OR (95% CI)<td>AOR (95% CI)*<td>%<td>OR (95% CI)<td>AOR (95% CI)*<td></td></td></td></td></td></td>	OR (95% CI) <td>AOR (95% CI)*<td>%<td>OR (95% CI)<td>AOR (95% CI)*<td></td></td></td></td></td>	AOR (95% CI)* <td>%<td>OR (95% CI)<td>AOR (95% CI)*<td></td></td></td></td>	% <td>OR (95% CI)<td>AOR (95% CI)*<td></td></td></td>	OR (95% CI) <td>AOR (95% CI)*<td></td></td>	AOR (95% CI)* <td></td>				
Wheezing last 12 months	17.1	1.0		23.1	1.46 (1.10–1.94)	1.54 (1.14–2.10)	19.7	1.19 (1.02–1.39)	1.32 (1.11–1.56)	17.1	1.00 (0.82–1.22)	1.32 (1.06–1.65)	<0.01
Cough at night last 12 months	4.9	1.0		12.3	2.76 (1.85–4.12)	2.03 (1.31–3.14)	7.9	1.70 (1.30–2.21)	1.54 (1.17–2.04)	7.4	1.56 (1.14–2.14)	1.60 (1.13–2.26)	0.02
apart from colds													
Asthma diagnosed by doctor	3.7	1.0		5.6	1.55 (0.91–2.64)	1.28 (0.72–2.28)	5.1	1.41 (1.04–1.92)	1.31 (0.94–1.81)	6.7	1.87 (1.32–2.66)	1.76 (1.20–2.60)	0.06
Rhinitis last 12 months	8.5	1.0		17.7	2.32 (1.66–3.23)	1.64 (1.14–2.35)	11.5	1.40 (1.14–1.73)	1.13 (0.90–1.41)	11.5	1.39 (1.08–1.79)	1.21 (0.92–1.60)	0.05
Hay fever diagnosed by doctor	0.9	1.0		3.3	3.91 (1.72–8.78)	2.25 (0.96–5.27)	2.1	2.39 (1.31–4.34)	1.48 (0.80–2.75)	3.7	4.33 (2.31–8.15)	2.39 (1.23–4.63)	0.02
Eczema last 12 months	13.2	1.0		23.1	1.99 (1.49–2.65)	1.58 (1.16–2.16)	20.6	1.71 (1.45–2.03)	1.44 (1.20–1.73)	18.7	1.52 (1.24–1.87)	1.25 (1.00–1.57)	0.04
Allergic reactions to food	15.5	1.0		20.4	1.40 (1.04–1.88)	1.15 (0.83–1.58)	21.1	1.46 (1.24–1.71)	1.30 (1.10–1.55)	18.5	1.24 (1.02–1.51)	1.15 (0.92–1.43)	0.08
More than six colds last 12 months	11.5	1.0		23.5	2.38 (1.77–3.19)	2.65 (1.92–3.66)	21.4	2.10 (1.75–2.51)	2.50 (2.07–3.03)	14.3	1.28 (1.03–1.60)	2.15 (1.68–2.75)	<0.01
Ear infection ever	42.4	1.0		61.7	2.19 (1.72–2.77)	2.03 (1.57–2.63)	64.4	2.46 (2.18–2.77)	2.16 (1.90–2.47)	62.0	2.21 (1.90–2.57)	1.64 (1.39–1.94)	0.34

*Adjusted odds ratio (AOR), adjusted for gender, age, siblings, smoking parent, atopic parent, single parenthood, furred pet in the home, breastfeeding <3 months, type of house (home), and urbanity.

†Linear by linear association for trends for starting age at day-care centre vs symptoms.

group of children with few colds (less than six colds) during the past year had the highest ORs and AORs for allergic diseases associated with day-care centre attendance compared with children with a larger number of colds. This indicates that the higher risk for allergic diseases in children attending day-care centres should be explained by other factors than frequent infections. Building ventilation rate, quality and frequency of cleaning and other building related factors should be considered. Another recognized property of day-care centres is the presence of allergens from furred pets, a prerequisite for allergic sensitization and contributing to expression of symptoms (23).

The question whether exposure to early infections in terms of day care is a risk or a protection against future allergic disease or asthma (allergic and nonallergic) is ambiguous (24). Most asthma exacerbations in school age are caused by viral infections in the respiratory tract, mainly rhinovirus (25). In infants and small children respiratory syncytial virus (RSV) is a main cause of lower respiratory symptoms (26). RSV infection in very early age has been related to asthmatic symptoms later in childhood (27), in the Tucson Children's Respiratory Study up through 11 years of age (28).

In a number of epidemiological studies early upper respiratory tract infections have been followed by a lower occurrence of asthma (8, 29) and atopy (30) sometimes after an initial increase in asthma occurrence (8). Other studies of early respiratory infections have exhibited an increased prevalence of atopy (31) and asthma (32), particularly after RSV infections (26, 27). Day-care attendance, particularly during the two first years of life and in absence of older siblings, is reported to imply some protection against later asthma and allergy (8, 29, 10, 33). In adults, an increased exposure to infections has also been suggested to cause a lower occurrence of adult hay fever after childhood day-care attendance in the ECRHS study (34). There are other studies with no effect on asthma or allergy of early respiratory infections or infectious exposure in terms of day care (35–37). A 13-year follow-up study showed that children in large day-care centres suffered more often from common cold than children in home care, but during the early school years earlier day-care attendance was a protective factor for common cold until about 13 years of age (9). When we stratified our data into two groups of ages (1–4 and 5–6 years), the prevalence of symptoms were higher among children attending day-care centres in both age groups, but the relationship was stronger in the age group 1–4 years. However, the prevalence of asthma among the children 5–6 years of age at home and in day care were mainly the same (4.9% and 5.5%), and an evidence for a potential 'protective' effect could not be seen.

A German study by Kramer *et al.* (10) found that an early start of day-care (before 6 months) decreased the risk for atopy, hay fever and irritated eyes later in life especially for children from small families. In our study, a

somewhat higher risk for asthma (P -trend = 0.06) and hay fever (P -trend = 0.02) were observed in the group of children entering day-care centre care after 2 years of age compared with children who started earlier. However, the accuracy of the trend value for hay fever in Table 5 could be questioned as the prevalence is very low (2.1–3.7%). In our data, only 4.9% of the children attending day-care centres started during their first year of life which might affect the comparisons with studies from some other countries.

The study only included preschool children between 1 and 6 years of age, which leaves the long-term development of respiratory and atopic conditions an open question, a challenge for a follow-up study. But even if the increase of disease related to day care may level out later in life, the reported amount of disease and symptoms during the preschool age involves a considerable strain for the children and their families as well as an economic load for the society. The decrease in hospital-

ization for childhood asthma during the last decades does not include the first four years of life (38), when the asthma morbidity still often requires hospital care.

Our study did not show any protective effect of day-care attendance for any symptom in any age group. On the contrary, there was an increased risk for most symptoms studied, particularly in the lower age groups. Considering the significant increase of the allergic diseases in Sweden over the last decades (2, 39) our findings justify a significant public health concern.

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References

1. Beasley R, Ellwood P, Asher I. International patterns of the prevalence of pediatric asthma the ISAAC program. *Pediatr Clin N Am* 2003;**50**:539–553.
2. Aberg N. Asthma and allergic rhinitis in Swedish conscripts. *Clin Exp Allergy* 1989;**19**:59–63.
3. Bornehag CG, Sundell J, Hagerhed-Engman L, Sigsgaard T. Association between ventilation rates in 390 Swedish homes and allergic symptoms in children. *Indoor Air* 2005;**15**:275–280.
4. Bornehag CG, Sundell J, Weschler CJ, Sigsgaard T, Lundgren B, Hasselgren M et al. The association between asthma and allergic symptoms in children and phthalates in house dust: a nested case-control study. *Environ Health Perspect* 2004;**112**:1393–1397.
5. Bornehag CG, Sundell J, Bonini S, Custovic A, Malmberg P, Skerfving S et al. Dampness in buildings as a risk factor for health effects, EUROEXPO: a multidisciplinary review of the literature (1998–2000) on dampness and mite exposure in buildings and health effects. *Indoor Air* 2004;**14**:243–257.
6. Etzel RA. How environmental exposures influence the development and exacerbation of asthma. *Pediatrics* 2003;**112**:233–239.
7. Strachan DP. Hay fever, hygiene, and household size. *BMJ* 1989;**299**:1259–1260.
8. Ball TM, Castro-Rodriguez JA, Griffith KA, Holberg CJ, Martinez FD, Wright AL. Siblings, day-care attendance, and the risk of asthma and wheezing during childhood. *N Engl J Med* 2000;**343**:538–543.
9. Ball TM, Holberg CJ, Aldous MB, Martinez FD, Wright AL. Influence of attendance at day care on the common cold from birth through 13 years of age. *Arch Pediatr Adolesc Med* 2002;**156**:121–126.
10. Kramer U, Heinrich J, Wjst M, Wichmann HE. Age of entry to day nursery and allergy in later childhood. *Lancet* 1999;**353**:450–454.
11. Bradley RH. Child care and common communicable illnesses in children aged 37 to 54 months. *Arch Pediatr Adolesc Med* 2003;**157**:196–200.
12. Louhiala PJ, Jaakkola N, Ruotsalainen R, Jaakkola JJ. Form of day care and respiratory infections among Finnish children. *Am J Public Health* 1995;**85**:1109–1112.
13. Nafstad P, Hagen JA, Oie L, Magnus P, Jaakkola JJ. Day care centers and respiratory health. *Pediatrics* 1999;**103**:753–758.
14. Bornehag CG, Sundell J, Sigsgaard T. Dampness in buildings and health (DBH): Report from an ongoing epidemiological investigation on the association between indoor environmental factors and health effects among children in Sweden. *Indoor Air* 2004;**14**(Suppl. 7):59–66.
15. Bornehag CG, Sundell J, Hagerhed-Engman L, Sigsgaard T, Janson S, Aberg N. 'Dampness' at home and its association with airway, nose, and skin symptoms among 10 851 preschool children in Sweden: a cross-sectional study. *Indoor Air* 2005;**15**(Suppl. 10):48–55.
16. Asher MI, Keil U, Anderson HR, Beasley R, Crane J, Martinez F et al. International Study of Asthma and Allergies in Childhood (ISAAC): rationale and methods. *Eur Respir J* 1995;**8**:483–491.
17. Celedon JC, Litonjua AA, Weiss ST, Gold DR. Day care attendance in the first year of life and illnesses of the upper and lower respiratory tract in children with a familial history of atopy. *Pediatrics* 1999;**104**:495–500.
18. Salam MT, Li YF, Langholz B, Gilliland FD. Early-life environmental risk factors for asthma: findings from the Children's Health Study. *Environ Health Perspect* 2004;**112**:760–765.
19. Nafstad P, Magnus P, Jaakkola JJ. Early respiratory infections and childhood asthma. *Pediatrics* 2000;**106**:E38.
20. Dahl IL, Grufman M, Hellberg C, Krabbe M. Absenteeism because of illness at daycare centers and in three-family systems. *Acta Paediatr Scand* 1991;**80**:436–445.
21. Benn CS, Melbye M, Wohlfahrt J, Bjorksten B, Aaby P. Cohort study of sibling effect, infectious diseases, and risk of atopic dermatitis during first 18 months of life. *BMJ* 2004;**328**:1223.

22. Kerkhof M, Koopman LP, van Strien RT, Wijga A, Smit HA, Aalberse RC et al. Risk factors for atopic dermatitis in infants at high risk of allergy: the PIAMA study. *Clin Exp Allergy* 2003;**33**:1336–1341.
23. Munir AK, Einarsson R, Dreborg SK. Mite (Der p I, Der f I), cat (Fel d I) and dog (Can f I) allergens in dust from Swedish day-care centres. *Clin Exp Allergy* 1995;**25**:119–126.
24. Nystad W. Daycare attendance, asthma and atopy. *Ann Med* 2000;**32**:390–396.
25. Johnston SL, Pattemore PK, Sanderson G, Smith S, Lampe F, Josephs L et al. Community study of role of viral infections in exacerbations of asthma in 9–11 year old children. *BMJ* 1995;**310**:1225–1229.
26. Darville T, Yamauchi T. Respiratory syncytial virus. *Pediatr Rev* 1998;**19**:55–61.
27. Sigurs N. A cohort of children hospitalised with acute RSV bronchiolitis: impact on later respiratory disease. *Paediatr Respir Rev* 2002;**3**:177–183.
28. Stein RT, Sherrill D, Morgan WJ, Holberg CJ, Halonen M, Taussig LM et al. Respiratory syncytial virus in early life and risk of wheeze and allergy by age 13 years. *Lancet* 1999;**354**:541–545.
29. Celedon JC, Wright RJ, Litonjua AA, Sredl D, Ryan L, Weiss ST et al. Day care attendance in early life, maternal history of asthma, and asthma at the age of 6 years. *Am J Respir Crit Care Med* 2003;**167**:1239–1243.
30. Illi S, von Mutius E, Lau S, Bergmann R, Niggemann B, Sommerfeld C et al. Early childhood infectious diseases and the development of asthma up to school age: a birth cohort study. *BMJ* 2001;**322**:390–395.
31. Bager P, Westergaard T, Rostgaard K, Hjalgrim H, Melbye M. Age at childhood infections and risk of atopy. *Thorax* 2002;**57**:379–382.
32. Nystad W, Nafstad P, Jaakkola JJ. The effect of respiratory tract infections on reported asthma symptoms. *Scand J Public Health* 2002;**30**:70–75.
33. Infante-Rivard C, Amre D, Gautrin D, Malo JL. Family size, day-care attendance, and breastfeeding in relation to the incidence of childhood asthma. *Am J Epidemiol* 2001;**153**:653–658.
34. Svanes C, Jarvis D, Chinn S, Omenaas E, Gulsvik A, Burney P. Early exposure to children in family and day care as related to adult asthma and hay fever: results from the European Community Respiratory Health Survey. *Thorax* 2002;**57**:945–950.
35. Cohet C, Cheng S, MacDonald C, Baker M, Foliaki S, Huntington N et al. Infections, medication use, and the prevalence of symptoms of asthma, rhinitis, and eczema in childhood. *J Epidemiol Community Health* 2004;**58**:852–857.
36. Pekkanen J, Remes S, Kajosaari M, Husman T, Soininen L. Infections in early childhood and risk of atopic disease. *Acta Paediatr* 1999;**88**:710–714.
37. Nafstad P, Jaakkola JJ, Skrandal A, Magnus P. Day care center characteristics and children's respiratory health. *Indoor Air* 2005;**15**:69–75.
38. Wennergren G, Strannegard IL. Asthma hospitalizations continue to decrease in schoolchildren but hospitalization rates for wheezing illnesses remain high in young children. *Acta Paediatr* 2002;**91**:1239–1245.
39. Aberg N, Hesselmar B, Aberg B, Eriksson B. Increase of asthma, allergic rhinitis and eczema in Swedish schoolchildren between 1979 and 1991. *Clin Exp Allergy* 1995;**25**:815–819.