European Journal of Epidemiology (2005) 20: 467–474
DOI 10.1007/s10654-005-0719-2

Socioeconomic factors and risk of hospitalization with infectious diseases in 0- to 2-year-old Danish children

Nana Thrane[1,2,3], Charlotte Søndergaard[3], Henrik Carl Schønheyder[1,4] & Henrik Toft Sørensen[1,2]

[1]*Department of Clinical Epidemiology, Aalborg University Hospital, Denmark;* [2]*Danish Epidemiology Science Centre, University of Aarhus, Denmark;* [3]*Department of Pediatrics, Herning Central Hospital, Denmark;* [4]*Department of Clinical Microbiology, Aalborg Hospital, Denmark*

Accepted in revised form 17 January 2005

Abstract. Although the association between low socioeconomic status and illness in childhood is well known, the impact of socioeconomic factors on risk and frequency of hospitalizations for infectious diseases, the most frequent disease category, during the first 2 years of life has scarcely been studied. Through linkage of records drawn from public administrative and health registries, we conducted a population-based cohort study of 5024 Danish children born in 1997 to examine the frequency of hospitalization for infectious diseases in very young children. The main exposure variables, adjusted for potential confounding factors, were mother's education level, household income, and cohabitation status. The outcome was number of hospital admissions (0, 1–2, or 3+) for infectious diseases. A total of 737 children (14.7%) were admitted to hospital 1–2 times, and 83 (1.6%) were admitted 3–10 times. The risk of hospitalization was increased in children of mothers with a low level of education compared with vocational education (1–2 admissions: adjusted odds ratio (OR) 1.3 (95% confidence interval [CI]: 1.1–1.6). Children from low-income families had an increased risk of 3 or more admissions (low *cf* middle income: adjusted OR 2.0 [95% CI: 0.6–6.0]). Children of single mothers had an increased risk of hospitalization (1–2 admissions: adjusted OR 1.7 [95% CI: 1.1–2.6]. We found the highest risk of hospitalization for infectious diseases in children of mothers with only basic schooling, and particularly among those coming from single parent homes with a low income.

Abbreviations: CI = confidence interval; ICD = international classification of diseases; OR = odds ratio

Introduction

Infections are the most frequent diseases in children and account for the largest number of hospital admissions [1, 2]. During the past decades, hospital admission rates of children have increased in several countries [1–4].

In Denmark, 21.7% and 28.9% of children were admitted to hospital during their first year of life during 1978 and 1995, respectively. However, the data included all admissions, including diseases in the perinatal period (prematurity, hypoglycaemia, etc.) [1].

Children from families with a lower socioeconomic status are known to be at higher risk of a wide range of communicable diseases. Respiratory tract infection, for example, has been associated with a low level of education and unemployment [5–8]. However, the impact of socioeconomic factors on the frequency of admissions during childhood is complex and scarcely examined [9]. Several other risk factors are associated with infectious morbidity, e.g., day care attendance, siblings, breast-feeding, and mother's smoking during pregnancy, which may interact with the social environment [6, 10–12].

In this population-based cohort study on admissions to hospital with infectious disease during the first 2 years of life, we examined (1) the frequency of hospital admissions, and (2) the impact of mother's education level, household income, and parental cohabitation status, taking into account potential confounders of the association.

Methods

Study population

The study population included all children born during 1997 in the North Jutland County, Denmark, who lived in the county during the entire study period January 1 1997 through December 1999 ($n = 5641$).

Data were extracted from the North Jutland Birth Registry, which provides complete information on all pregnancies and births in the county since 1973. The data are recorded by the midwives during pregnancy and delivery.

Excluded from the cohort were 10 children who did not have a personal registration number (refugee status) assigned to all Danish citizens since 1968 by the Central Office of Civil Registration. Also excluded were children who died during the study period ($n = 40$), of whom 32 died before they reached the age of 4 months.

We did not have access to data on day care from 5 (10.9%) of North Jutland County's 27 municipalities due to refusal to participate in the study or lack of usable registries. Thus, the 567 children in those 5 municipalities were excluded, leaving 5024 children for the final analyses.

Social factors

We extracted data from the National Statistical Office of Denmark [13–14] (registered November 1996) concerning the mother's highest educational level (completed or ongoing): basic schooling <10 years, advanced schooling equivalent to 11 or 12 years, vocational education and training for 1–3 years, higher education for 1–4 years, and higher education for >4 years. To attend higher education, a minimum of 12 years of schooling is required. Data on the education of the mothers of 33 children (0.7%) were missing and excluded from the analyses.

When analyses were performed with the highest parental education level as the exposure variable, no difference was found in the results.

We categorized household income as follows: <135,000 DKK (~5% of the population); 135,000–307,000 DKK (~20% of the population); 308,000–459,000 DKK (~50% of the population); 460,000–620,000 DKK (~20% of the population); and >620,000 DKK (~5% of the population). In stratified analyses (investigating effect modification), income was divided into three categories: low: <135,000 DKK; middle: 135,000–620,000 DKK; and high: >620,000 DKK. Information on income of the mothers of 186 children (3.7%) was missing and excluded from the analyses.

Data from the North Jutland Birth Registry included parental cohabitation status, i.e., the mother living alone or cohabiting with the father during early pregnancy (yes/no).

Hospitalization

In Denmark, hospital care is free of charge and available to all. Before admission, the vast majority of children are examined by a general practitioner. We identified the diagnoses for the study population on all hospital admissions from January 1, 1997, to December 31, 1999, from the County Hospital Discharge Registry covering all hospitals in the county. The discharge diagnoses originated from the summary abstract performed by a physician at the time of discharge of the patient. These were classified according to *International Classification of Diseases, 10th Revision* (ICD-10).

We excluded admissions during the first week of life, since these were mainly due to perinatal complications. The children were followed up to their second birthday. The diagnoses were classified into types of infection: unspecified viral infections; otitis media; upper respiratory tract infections; lower respiratory tract infections; infections with asthmatic component; febrile convulsions; gastroenteritis; and miscellaneous (Table 1). For each patient, several infectious co-diagnoses may be present at each admission. Non-infectious diagnoses were not included ($n = 1505$). For each child, the number of admissions with at least one infectious diagnosis was calculated and grouped: no admission, 1–2, and 3+ admissions.

Confounding factors

Information on potential confounders of the association between socioeconomic factors on hospitaliza-

Table 1. Discharge diagnoses. Codes in ICD-10 for infectious diseases included in the study

Infectious diseases	Codes in ICD-10	Number of admissions[a]	Number of children[b]
Unspecified viral infection	B34, R50	167	161
Otitis media	H65-66	162	136
Upper respiratory tract infections	J00-11, R05	176	161
Lower respiratory tract infections	J12-22, J40	338	263
Infections with asthmatic component	J44, J45	283	199
Febrile convulsions	R560	167	129
Gastroenteritis	A08-9	102	94
Miscellaneous	A37-41, A87, G00-04 H10-13, L00-04	41	36

[a] Does not equal number of children because of multiple diagnoses per hospitalization.
[b] Does not sum up to the number of children in the study because of multiple diagnoses per child.

tion was considered. Data from the North Jutland Birth Registry included gender, birth weight (< 2500, 2500–4500, and >4500 g), gestational age (< 37, 37–41, and >41 weeks), the mother's age at time of delivery, her smoking habits in early pregnancy (yes/no), and older siblings in the home (0/1+).

We used the County Discharge Hospital Registry to collect data on other diseases that may have influenced the risk of hospitalization with infectious disease, i.e., respiratory distress in the perinatal period and heart disease.

In Denmark, public day care is administered by the municipalities and organized as day care homes with a single child-minder who takes care of 1–4 children in the private home, or day care centers where 20–80 children are cared for in a facility established for that purpose. Information on day care settings for the 5024 children was obtained for January 1, 1997, through June 30, 1999, from municipality registries.

Record linkage

The study database was established by record linkage of information from the registries using the unique personal identification number, given to each Danish citizen at birth [15].

Statistical methods

We constructed Kaplan–Meier survival curves to show the cumulative incidence of admission to hospital according to age and used Cox regression models to estimate the cumulative incidence rate ratio for boys compared with girls. Adjustment for potential confounders did not change the risk estimate. The proportional hazard assumption was checked by a plot of residuals.

Using contingency tables, we examined the crude association between socioeconomic factors (mother's education, household income, cohabitation status) and frequency of hospital admissions. The Cox regression model is based on time to event, e.g., first hospitalization. However, one of our main purposes was to examine the frequency of admissions during a period of time in relation to socioeconomic factors. Therefore, the associations were presented as odds ratios (ORs) with 95% confidence intervals (CI) using multinomial logistic regression [16].

For each of the exposure variables, we adjusted the influence of potential confounding factors and the two other socioeconomic variables. Finally, we fitted a logistic regression model, which included only variables such as exposure and confounders that changed the crude ORs by more than 10% [17]. Thus, none of the following factors – birth weight, gestational age, gender, day care, or other diseases – confounded the risk estimates. For each of the socioeconomic exposure variables, we combined stratified analysis with logistic regression analysis to examine variation in risk estimates across strata (effect modification). The stratification was done subsequently for all of the potential confounding factors and for the two other socioeconomic variables. The Hosmer Lemeshow's goodness-of-fit test was used to assess the fit of the model using the individual logistic regressions approach [16]. Data analyses were performed in *SPSS, version 10.0* (SPSS, Chicago, IL).

Results

Characteristics of cohort and hospital admissions

We recorded 1195 admissions with 1452 diagnoses due to infectious diseases (Table 1). The cumulative incidence was 10.1% during the first year and 16.3% during the first 2 years of life. The cumulative incidence rate ratio was 1.5 (95% CI: 1.3-1.7) for boys compared with girls (Figure 1).

A total of 737 out of 5024 children (14.7%) were admitted 1–2 times, and 83 (1.6%) were admitted 3–10 times. The children with 3 or more hospitalizations, which constituted 10% of children with hospitalizations, accounted for 27% of number of admissions. Table 2 shows the characteristics of the children in the cohort.

Social factors and risk of hospital admissions

The risk of hospitalization was increased in children from families where the mother had a basic level of schooling compared with vocational education (1–2 admissions: adjusted OR 1.3 [95% CI: 1.1–1.6] (Table 3). The associations persisted after adjusting for household income, cohabitation status, maternal age, and smoking during pregnancy, all of which indicate an independent effect of education level.

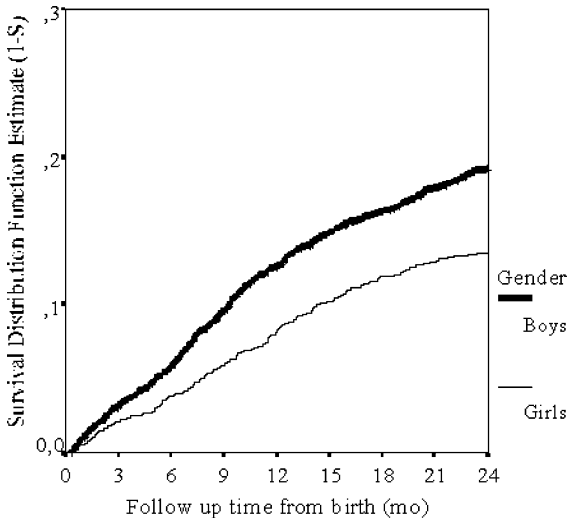

Figure 1. Kaplan–Meier survival curve (1-S). Cumulative incidence proportion of children admitted to hospital with infectious disease according to age and gender.

Table 2. Characteristics of children in the cohort ($N = 5024$), percentages within number of admissions to hospital with infectious disease during the first two years of life

	Overall number	No admission $n = 4204$ (83.7%)	1–2 admissions $n = 737$ (14.7%)	≥ 3 admissions $n = 83$ (1.6%)
Mother's education				
Basic schooling ≤10 years	1447	79.7	17.8	2.5
Schooling 11–12 years	163	84.1	14.7	1.2
Vocational education	2107	85.4	13.2	1.4
Higher education 1–4 years	1035	84.5	14.3	1.2
Higher education >4 years	239	88.7	10.5	0.8
Unknown	33	84.9	12.1	3.0
Household income (DKK[a])				
<135,000	237	76.4	19.0	4.6
135,000–307,000	977	81.8	16.3	1.9
308,000–459,000	2415	84.7	13.9	1.4
460,000–620,000	963	84.7	14.2	1.1
>620,000	246	86.3	12.5	1.2
Unknown	186	80.6	17.2	2.2
Cohabitation status of the mother				
Single	231	73.2	22.5	4.3
Cohabiting	4793	84.2	14.3	1.5
Gender				
Girl	2462	86.6	12.2	1.2
Boy	2562	80.9	17.0	2.1
Birthweight (g)				
<2500	236	77.1	18.7	4.2
2500–4500	4590	84.1	14.4	1.5
>4500	198	82.3	15.7	2.0
Gestational age (week)				
<37	300	75.3	20.4	4.3
37–41	4280	84.1	14.4	1.5
>41	444	85.1	13.3	1.6
Siblings				
0	2043	85.7	13.1	1.2
≥1	2981	82.2	15.8	2.0
Mother smoking during pregnancy				
No	3629	85.2	13.5	1.3
Yes	1395	79.7	17.7	2.6
Mother's age at time of birth (years)				
<20	85	78.9	17.6	3.5
20–25	1134	83.0	14.5	2.5
26–34	3199	84.0	14.7	1.3
>34	606	84.0	14.5	1.5
Type of day care				
Day care home	3601	84.0	14.4	1.6
Day care center	244	79.5	18.9	1.6
Mixed[b]	94	73.4	22.3	4.3
No day care	1085	84.4	14.1	1.5
Age at enrollment in day care (months)				
0–4	135	74.1	21.5	4.4
5–7	1596	83.2	14.3	2.5
8–12	1290	83.3	15.6	1.1
13–17	637	86.8	12.3	0.9
18–23	281	82.6	16.7	0.7
Other disease				
Heart disease	24	45.8	33.4	20.8
Perinatal respiratory distress	82	51.2	41.5	7.3
Both	6	50.0	50.0	–

[a]Danish kroner.
[b]Children who changed type of day care during the study period.

Table 3. Association between mother's education level and household income and admission to hospital during the first two years of life

		1–2 admissions			≥ 3 admissions		
	N	*n*	Crude OR [95% CI]	Adjusted OR [95% CI]	*n*	Crude OR [95% CI]	Adjusted OR [95% CI]
Mother's education							
Basic schooling = 10 years	1447	257	1.4 [1.2–1.7]	1.3 [1.1–1.6][a]	36	1.9 [1.2–3.1]	1.3 [0.8–2.3][a]
Schooling 11,12 years	163	24	1.1 [0.7–1.7]	1.1 [0.7—1.8][a]	2	0.9 [0.2–3.7]	0.8 [0.2–3.1][a]
Vocational education	2107	279	reference	reference	30	reference	reference[a]
Higher education 1,4 years	1035	148	1.1 [0.9–1.3]	1.1 [0.9–1.4][a]	12	0.8 [0.4–1.6]	0.9 [0.5–1.8][a]
Higher education >4 years	239	25	0.8 [0.5–1.2]	0.8 [0.5–1.2][a]	2	0.5 [0.1–2.4]	0.6 [0.1–2.5][a]
Household income, DKK							
<135,000	237	45	1.5 [1.1–2.1]	1.0 [0.6–1.6][b]	11	3.6 [1.8–7.1]	2.0 [0.6–6.0][b]
136,000–307,000	977	159	1.2 [1.0–1.5]	1.1 [0.9–1.4][b]	19	1.4 [0.8–2.4]	1.1 [0.6–2.1][b]
308,000–459,000	2415	334	reference	reference	35	reference	reference
460,000–620,000	963	136	1.0 [0.8–1.3]	1.1 [0.9–1.3][b]	11	0.8 [0.4–1.6]	1.1 [0.5–1.9][b]
>620,000	246	31	0.9 [0.6–1.3]	1.0 [0.6–1.5][b]	3	0.8 [0.3–2.7]	1.0 [0.3–3.6][b]

[a] The multinomial logistic regression model included mother's education, household income, marital status, maternal age, and smoking during pregnancy.
[b] The multinomial logistic regression model included household income, mother's education, marital status, maternal age, smoking during pregnancy, and siblings.

The crude analyses showed that children from families with a low income had a higher risk of hospitalization compared with a middle level of income (Table 3). However, after adjusting for confounding from education, cohabitation status, maternal age, smoking, and siblings, we found no association of income on the risk of 1–2 admissions and a substantial change in risk of 3+ admissions (crude OR = 3.6 [95% CI: 1.8–7.1] and adjusted OR = 2.0 [95%CI: 0.6–6.0]).

In the crude analyses, children from families where the mother was a single parent had two- to three-fold higher risk of hospitalization compared with children from families where the mother was cohabiting with the father (Table 4). However, adjustment showed that some of the effect was due to a higher proportion of smokers and a low household income among single mothers. Stratified analyses showed a trend toward a stronger effect of cohabitation status on the risk of hospitalization in families with low income (Table 4).

We found no substantial sign of effect modification between socioeconomic factors and other risk factors for hospitalization, i.e., gender, day care, siblings, and smoking during pregnancy.

For each infectious disease category, we analyzed the impact of education level, household income, and cohabitation status on the risk of at least one hospitalization. The trend was homogeneous throughout the disease categories, although minor differences existed.

Discussion

The association between low socioeconomic status and illness in childhood is well known. The contribution of this study is the focus on hospitalization in early childhood due to infections, which is the most

Table 4. Association between cohabitation status of the mother and admission to hospital during the first two years of life

		1–2 admissions			≥3 admissions		
Cohabitation status	*N*	*n*	crude OR [95% CI]	adjusted OR [95% CI]	*n*	crude OR [95% CI]	adjusted OR [95% CI]
Overall							
Single	231	52	1.8 [1.3–2.5]	1.7 [1.1–2.6][a]	10	3.3 [1.7–6.4]	1.5 [0.5–4.3][a]
Cohabiting	4793	685	reference	reference	73	reference	reference
Stratum, household income							
Low income[b]	237	45			11		
Single vs cohabiting			3.5 [1.5–7.9]	2.7 [1.1–6.6][a]		3.4 [0.7–16.2]	3.2 [0.6–16.9][a]
Middle income[b]	4355	629			65		
Single vs. cohabiting			1.4 [0.8–2.4]	1.3 [0.8–2.4][a]		0.9 [0.1–6.4]	0.8 [0.1–6.9][a]

[a] The multinomial logistic regression model included household income, mother's education, marital status, maternal age, smoking during pregnancy, and siblings.
[b] Low income: < 135,000 DKK, middle income: 136,000–620,000 DKK.

frequent disease group, and the ability to study the frequency of admissions. The impact of education was present only in the outer ranges of the educational spectrum, and it was equal in children both with few and many admissions. Children from families with single mothers had an increased risk of hospitalization, particularly those coming from low-income families.

Strengths and limitations

The population-based design with prospective detailed data collection on an administrative basis ensured that selection bias due to loss of follow-up did not occur. The exclusion of five of 27 municipalities was independent of the outcome measure (hospitalizations), and this non-differential selection presumably does not affect the results. The validity of the data from the National Statistical Office of Denmark and the North Jutland Birth Registry is high [14–15, 18]. The information on exposure (education, income, and cohabitation status) was obtained at a fixed time and some of the mothers may have altered their status during the first years of the child's life. This will most likely bias the association towards the null-hypothesis.

Previous studies have shown high validity in the discharge registry regarding the diagnosis of severe infections [19]. The information on hospitalizations was independent of registration of exposures. Thus, any misclassification of discharge diagnoses is non-differential and bias the risk estimate towards one [20]. Some children may have been admitted to hospitals outside the North Jutland County (<2%) and this lack of information would also bias the association towards unity.

We had data on major confounding factors, e.g., smoking during pregnancy, day care attendance, siblings, and other diseases. However, the study lacks information on the duration of breast-feeding, which is associated with both socioeconomic factors and the risk of infectious disease.

Frequency of admissions

Our findings regarding proportion of children admitted to hospital and numbers of admissions are similar to a study from the United Kingdom conducted in 1985 [3]. Children with multiple admissions use a disproportionately high share of hospital healthcare services since the small number of children with more than 3 admissions accounted for 25–30% of total admissions.

Association between socioeconomic factors and admission

Our ability to link information on antenatal, perinatal, and socioeconomic factors to subsequent hospital admissions for a large group of infants has rarely been achieved for other populations [11]. Thus, few published data are available for direct comparison. Further, different measurements of socioeconomic position and/or categorizing of variables are used, and, therefore, comparisons rely on trends in associations rather than exact measures of risk estimates.

Several ecological studies are consistent in showing that children who live in deprived areas have a higher risk of at least one hospitalization owing to infectious disease [21–23]. In addition, Spencer reported the risk of multiple admissions to be 1.5 times higher in children from deprived areas [9]. However, ecological studies are not able to examine confounding factors and the aggregation process may produce errors of inference [20].

In accordance with our findings, studies from the United States and Sweden showed an association between a low level of education and hospitalization due to infectious disease [11, 24]. A Danish study from 1977, on the contrary, found hospitalizations because of infections to be most frequent among children from highly educated families [25]. However, this study was small, included children of all ages, excluded a large proportion of children for various reasons, and the level of education was divided at 9 years of schooling only. A recent study from the United Kingdom found no evidence of differences in social class and hospital admission in the recent year for 0- to19-year-old children, but the methods and conclusions were questioned by other researchers [26].

Several studies report that children of single mothers had a higher risk of hospitalization [24, 27]. Hjern et al. found the risk to be decreased by 0.9 in children of single mothers [11]. However, 30% were categorized as single, suggesting that information on marriage may have been used instead of cohabitation.

Interpretation

The influence of socioeconomic factors on health involves environmental factors and psychological factors [28]. A greater risk of infectious disease among people with lower socioeconomic position is thought to be attributable to increased exposure to infectious agents (e.g., due to crowding or poorer hygiene practices) and decreased host resistance to infection (e.g., due to nutrition, smoking, or stress) [5]. In our study, smoking and crowding (siblings, day care) were risk factors which could not explain the socioeconomic associations and we had no information regarding nutrition or stress.

About 20% of admissions of children are categorized as 'inappropriate' or 'ambulatory care sensitive (ACS)', i.e., conditions which according to either the receiving physician or a classification system do not

require hospitalization [29–30]. The admitting physician's judgment of the capability of the parents to take care of their sick child at home may influence the decision of admission. This statement may be supported by the excess risk of hospitalization seen among children of single mothers in our study.

Our study showed that socioeconomic factors have small impact on the risk of hospitalization in Danish children. The highest risk is seen in children of mothers with only basic schooling, which in the present study accounted for 28% of the population, and especially those coming from single parent homes with a low income.

Acknowledgements

We thank the staff at the Department of Health Insurance and Preventive Medicine and the Hospital Registries in the County of Northern Jutland for excellent assistance in preparing the data for analyses.

This work received assistance from the National Centre for Register-based Research, funded by the Danish National Research Foundation. The study was funded by the Helsefonden, the Fund for Medical Science Research [Fonden til Lægevidenskabens Fremme], Rosalie Petersen's Fund, the Sociomedical Research Fund [Den Samfundsmedicinske Forskningsfond], and the Western Danish Research Forum for Health Sciences [Vestdansk Forskningsforum]. The activities of the Danish Epidemiology Science Centre are financed by a grant from the Danish National Research Foundation.

References

1. Nielsen A, Lie RL, Keiding L, Madsen M. Indlæggelser på sygehus. [Admissions in hospital]. In: Børns sundhed i Danmark [The health of children in Denmark]. Danish Institute of Clinical Epidemiology, Copenhagen 1998; 50–54: 76–83.
2. Hill AM. Trends in paediatric medical admissions. Br Med J 1989; 298: 1479–1483.
3. Spencer NJ, Lewis MA. Multiple admissions under 2 years of age. Arch Dis Childhood 1991; 66: 938–940.
4. Wickman M, Farahmand BY, Persson PG, Pershagen G. Hospitalization for lower respiratory disease during 20 yrs among under 5 yr old children in Stockholm County: A population based survey. Eur Resp J 1998; 11: 366–370.
5. Cohen S. Social status and susceptibility to respiratory infections. Ann New York Acad Sci 1999; 896: 246–253.
6. Graham NM. The epidemiology of acute respiratory infections in children and adults: a global perspective. Epidemiol Rev 1990; 12: 149–178.
7. Paradise JL, Rockette HE, Colborn DK, Bernard BS, Smith CG, Kurs-Lasky M, et al. Otitis media in 2253 Pittsburgh-area infants: Prevalence and risk factors during the first two years of life. Pediatrics 1997; 99: 318–333.
8. Egbouno L, Starfield B. Child health and social status. Pediatrics 1982; 69: 550–557.
9. Spencer NJ, Lewis MA, Logan S. Diagnostic and socio-demographic changes in multiple hospital admission in children under two over a five-year period. J Pub Health Med 1993; 15: 332–336.
10. Håkansson A, Carlsson B. Maternal cigarette smoking, breast-feeding, and respiratory tract infections in infancy. A population-based cohort study. Scand J Primary Health Care 1992; 10: 60–65.
11. Hjern A, Haglund B, Bremberg S. Lower respiratory tract infections in an ethnic and social context. Paediat Perinatal Epidemiol 2000; 14: 53–60.
12. Thrane N, Olesen C, Mortensen JT, Søndergaard C, Schønheyder HC, Sørensen HT. Influence of day care attendance on the use of systemic antibiotics in 0- to 2-year-old children. Pediatrics 2001; 107: E76.
13. IDA – en integreret database for arbejdsmarkedsforskning [IDA – An integrated Database for Labor Market]. The National Statistical Office of Denmark, Copenhagen, 1991.
14. Thygesen L. The register-based system of demographic and social statistics in Denmark. Stat J Un Econ Comm Eur 1995; 12: 49–55.
15. Frank L. When an entire country is a cohort. Science 2000; 287: 2398–99.
16. Hosmer DW, Lemeshow S. In: Applied logistic regression. New York: John Wiley & Sons, 1989.
17. Greenland S. Modeling and variable selection in epidemiologic analysis. Am J Pub Health 1989; 79: 340–349.
18. Kristensen J, Langhoff Roos J, Skovgaard LT, Kristensen FB. Validation of the Danish birth registration. J Clin Epidemiol 1996; 49: 893–897.
19. Sørensen HT, Hansen I, Ejlersen E, Sabroe S, Hamburger H. Identification of cases of meningococcal disease: data quality in two Danish population-based information systems during 14 years period. Inter J Risk Safety Med 1995; 7: 179–189.
20. Rothman KJ, Greenland S. In: Modern epidemiology. Philiadelphia: Lippicot-Raven Publishers, 1998.
21. McConnochie KM, Roghmann KJ, Liptak GS. Socioeconomic variation in discretionary and mandatory hospitalization of infants: an ecologic analysis. Pediatrics 1997; 99: 774–784.
22. Perrin JM, Homer CJ, Berwick DM, Woolf AD, Freeman JL, Wennberg JE. Variations in rates of hospitalization of children in three urban communities. New Eng J Med 1989; 320: 1183–1187.
23. Maclure A, Stewart GT. Admission of children to hospitals in Glasgow: relation to unemployment and other deprivation variables. Lancet 1984; 2: 682–685.
24. Berg AT, Shapiro ED, Capobianco LA. Group day care and the risk of serious infectious illnesses. Am J Epidemiol 1991; 133: 154–163.
25. Aagaard J. Social background and life events of children admitted to a paediatric department. Acta Paediat Scand 1979; 68: 531–539.
26. Cooper H, Smaje C, Arber S. Use of health services by children and young people according to ethnicity and social class: Secondary analysis of a national survey. Br Med J 1998; 317: 1047–1051.

27. Read AW, Gibbins J, Stanley FJ. Hospital admissions for lower respiratory tract illness before the age of two years in western Australia. Paediat Perinatal Epidemiol 1996; 10: 175–185.
28. Adler NE, Ostrove JM. Socioeconomic status and health: What we know and what we don't know. Ann New York Acad Sci 1999; 896: 3–15.
29. MacFaul R, Glass EJ, Jones S. Appropriateness of paediatric admission. Arch Dis Childhood 1994; 71: 50–58.
30. Casanova C, Starfield B. Hospitalizations of children and access to primary care: a cross-national comparison. Inter J Health Serv 1995; 25: 283–294.

Address for correspondence: Nana Thrane, Department of Pediatrics, Herning Central Hospital, Denmark
Phone: +45-9927-2727; Fax: +45-9721-2673
E-mail: n.thrane@dadlnet.dk