

ORIGINAL PAPER

The impact of selected behavioural and environmental factors on the incidence of upper respiratory tract infections in Polish children

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ABSTRACT

Introduction: To identify environmental and clinical factors and parental behaviours that are likely to affect the incidence of upper respiratory tract infection in the paediatric population.

Material and methods: This questionnaire-based, observational study was conducted among children < 10 years of age without chronic respiratory diseases, who sought medical assistance from a primary care paediatrician for upper respiratory tract infections (URTIs).

Results: A group of 4389 children were enrolled in this study. The mean age of the children participating in the study was 4.9 years. The study group included 2108 (48.0%) girls and 2281 (52.0%) boys, with no statistically significant difference between the genders in terms of age. The mean number of infections was significantly higher in children who had siblings, confirmed atopy, exposure to tobacco smoke, and a lack of vaccination ($p < 0.01$) and those who attended nurseries compared to preschool and school children ($p < 0.001$). The mean number of episodes of infection in medium-sized and large cities was significantly higher than in small towns and villages ($p < 0.01$). The mean number of missed school days for children who stayed at home due to infection was 20 days. The presence of cigarette smokers in a household significantly increased the number of missed days in nurseries/kindergartens/schools due to infection ($p < 0.01$).

Conclusions: Selected behavioural and environmental factors significantly impact the incidence of URTIs in children. Those factors indirectly negatively affect employers and the economy because they substantially increase hospitalization rates and the number of days missed at work by the parents/legal guardians of children. Therefore, ongoing parental education about the role of vaccinations and the harmful effects of tobacco smoke on children is necessary.

KEY WORDS:

antibiotic therapy, education, infectious diseases, paediatric primary care, vaccination.

INTRODUCTION

Upper respiratory tract infections (URTIs) are the most common reason for primary practice attendance among

children and are therefore an important social and epidemiological problem [1–3]. Their increased incidence in children results from the immaturity of the immune system and the significantly shorter length of the airways, which

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are a mechanical and physiological barrier for pathogens. Frequent contact with peers in a nursery, kindergarten, or school may be an additional factor contributing to the incidence of infections in this group of patients [1]. Respiratory tract infections are classified as URTIs (including rhinitis and paranasal sinusitis, acute pharyngitis and tonsillitis, and laryngitis) and lower respiratory tract infections (including bronchitis, bronchiolitis, and pneumonia) [2].

Studies have shown that most URTIs have viral aetiology. Viral infections are the cause of about 70–85% of pharyngitis and more than 90% of bronchitis cases [1, 2, 4]. Bacterial infections are much less common and usually develop as a secondary infection (superinfection) following a viral infection. These infections are a common reason for parental absence from work [5, 6]. This is undoubtedly an important economic problem for employers of parents of young children [5]. The prevalence of URTIs prompted us to assess the influence of environmental factors and those responsible for the behaviour of parents of selected groups of patients, which could have a significant impact on the incidence of infections. This non-interventional, observational questionnaire study among the parents and guardians of 4389 children treated for URTIs identified behaviours and environmental factors that were found to be important predictors of disease.

To identify environmental and clinical factors and parental behaviours that are likely to affect the incidence of URTIs in the paediatric population.

MATERIAL AND METHODS

This study had a questionnaire-based, observational, non-interventional design. No additional, non-standard medical procedures were performed. The study was conducted in an outpatient setting (primary health-care clinics) by paediatricians. Before inclusion in the study, all physicians were obliged to provide the patient with written information about the assumptions and goals of the program, and to obtain oral consent for participation from the parent/guardian.

The inclusion criteria were being aged < 10 years and attending an appointment with a general practitioner (GP) due to a URTI. The following exclusion criteria were used: chronic cough of unknown cause for > 4 weeks; respiratory defects (e.g. tracheoesophageal fistula); gastroesophageal reflux disease; cystic fibrosis; chronic cardiovascular disease; asthma; immune deficiencies; immunosuppressant therapy; and fever > 39°C.

As part of the study, each patient attended a GP visit during which their parent/guardian was asked to complete a questionnaire to specify the following personal data for the child: current weight; birth weight; height/body length; place of residence; exposure to tobacco smoke; attendance at a nursery/kindergarten/school; and history of respiratory diseases including recurrent URTIs, recurrent tonsillopharyngitis, chronic (including obstructive)

bronchitis, pneumonia within the past year, recurrent sinusitis, previous middle-ear infections, and bacterial superinfections. We also collected data on the factors increasing the risk of infection, including atopic diseases (e.g. asthma and allergy), malnutrition, obesity, having siblings, exposure to tobacco smoke, lack of vaccinations, breastfeeding, and the presence of gastroesophageal reflux and tonsillar hypertrophy. The questionnaire also inquired about the child's immunity, including data on the number of infections, antibiotic treatments, hospital stays and missed days at a nursery/kindergarten/school due to infection, as well as the number of symptoms suggestive of primary immunodeficiency. We also asked about the symptoms of infection that were the reason for the visit to the interviewing doctor and the treatment used. A test of parental knowledge of antibiotic therapy was an important element of the questionnaire. In this study, we assessed data only on environmental factors and parental behaviours that could have an impact on the incidence of URTIs and hospitalization rates, absence from day-care/educational institutions, and parental absence from work.

Statistical analysis was performed with the Statistica 13.3 PL version (StatSoft, Tulsa, USA). The Kolmogorov–Smirnov test was applied to verify a normal distribution. The mean values of certain parameters were compared using Student's *t*-test or the Mann-Whitney *U* test for quantitative variables and the chi-squared (χ^2) test for qualitative variables. The Kruskal-Wallis test was utilized for the analysis of variance. The correlation assessment was performed with the use of the Spearman's rank correlation coefficient. Statistical significance was considered as $p < 0.05$. The data are presented as the mean value $\pm$ the standard deviation (SD) or as a percentage of the patients in the analysed groups. The odds ratio and 95% confidence interval are reported.

RESULTS

In total, 4802 patients were enrolled in the study. Of these, 4386 were included in the statistical analysis. Overall, 413 patients (8.6% of those enrolled) were excluded due to incomplete data, failure to meet the inclusion criteria, or a lack of parental/guardian consent. The mean age of the children participating in the study was 4.9 years (with a median of 4.6 years), which fell between the lower quartile of 2.9 and the upper quartile of 6.6 years. The study group included 2108 (48.0%) girls and 2281 (52.0%) boys. There was no statistically significant difference between the genders in terms of age ($p = 0.5$). The girls had a statistically significantly lower birth weight ($p < 0.001$).

As reported by the parents/guardians, URTIs affected 3043 (69.3%) of the children: chronic (including obstructive) bronchitis had developed in 555 (12.6%) and pneumonia had occurred in 539 (12.3%) of the patients during the past year. The most common symptoms of infections in the patients included the following: rhinitis in

3262 (74.3%); cough in 2938 (66.9%); decreased appetite in 2869 (65.4%); deterioration of well-being in 2042 (46.5%); reduced physical activity in 1977 (45.0%); pharyngitis in 1894 (43.2%); hoarseness in 1471 (33.5%); and difficulty swallowing in 1171 (26.7%). The mean duration of symptoms in the children attending medical appointments was 3.7 days, with a median of 3 days, which fell within the lower quartile of 2 and the upper quartile of 5. The mean number of symptoms was 5, and this was significantly higher in the group of children who were exposed to tobacco smoke, attended educational institutions, had siblings, were treated with antibiotics, and presented with fever ($p < 0.01$) (Table 1).

Factors increasing the risk of infection were confirmed in 3160 (72.0%) of the respondents. Those most

common included having siblings (43.0%), atopic diseases (30.0%), and exposure to tobacco smoke (21.8%). Nurseries, kindergartens, and schools were attended by 561 (12.8%), 1842 (42.0%), and 593 (13.5%) of the patients, respectively. In total, 337 (7.7%) children were home-schooled. The mean number of infections was significantly higher in children who had siblings, confirmed atopy, exposure to tobacco smoke, and a lack of vaccination (t-test for groups, $p < 0.01$), and those who attended nurseries compared to preschool and school children (t-test for groups, $p < 0.001$) (Table 2).

Large ($> 100,000$ inhabitants) municipalities, small and medium-sized municipalities ($< 100,000$ inhabitants), and rural regions were the places of residence for 796 (18.1%), 1893 (43.2%), and 1700 (38.7%) of the pa-

TABLE 1. The presence of at least 5 symptoms of upper respiratory tract infections and selected environmental and clinical factors in the study group ($n = 4389$)

Risk factors	Number of patients with < 5 symptoms	Number of patients with ≥ 5 symptoms	χ^2 test
Cigarette smoke exposure	347	617	$p < 0.01$
No exposure to cigarette smoke	1595	1830	
Siblings	822	1152	$p = 0.02$
No siblings	1120	1295	
Day-care attendance	1232	1764	$p < 0.01$
No day-care attendance	710	683	
Normothermy	857	507	$p < 0.01$
Increased body temperature	1085	1940	
Antibiotic therapy	531	1373	$p < 0.01$
No antibiotics	1411	1074	

TABLE 2. Selected environmental factors and the number of upper respiratory tract infections in the study group ($n = 4389$)

Risk factor	Number of patients with infection	Number of patients without infection	Mean $\pm$ SD	Median (Q1–Q2)	p -value
Siblings	1152	822	3.4 ± 1.9	3 (2–4)	$p < 0.01$
No siblings	1295	1120	3.0 ± 1.9	3 (2–4)	
Allergy	317	834	3.8 ± 1.9	4 (3–5)	$p < 0.01$
No allergy	1613	1625	2.9 ± 1.8	3 (2–4)	
Exposure to tobacco smoke	617	347	3.6 ± 1.9	3 (2–5)	$p < 0.01$
No exposure to tobacco smoke	1830	1595	3.0 ± 1.9	3 (2–4)	
Nursery attendance	324	237	3.9 ± 2.1	4 (3–5)	$p < 0.01$
Nursery school attendance	1061	781	3.4 ± 1.8	3 (2–4)	
School attendance	379	214	2.8 ± 1.6	3 (2–4)	$p < 0.01$
Home schooling	154	183	2.4 ± 2.1	3 (1–4)	
Vaccinated	2369	1902	3.2 ± 1.9	3 (2–4)	$p < 0.01$
Non-vaccinated	78	40	3.7 ± 1.7	4 (3–5)	
Male gender	1296	985	3.2 ± 2.0	3 (2–4)	$p = 0.06$
Female gender	1151	957	3.1 ± 1.8	3 (2–4)	

SD – standard deviation

TABLE 3. Place of residence and number of upper respiratory tract infections in the study group ($n = 4389$)

Place of residence	Total number of patients	Number of patients with infection	Mean $\pm$ SD	Median (Q1–Q2)	p -value		
Total number of patients	4389	2447	3.2 $\pm$ 1.9	3 (2–4)			
Population size > 100,000	796	446	3.2 $\pm$ 1.9	3 (2–4)	$p < 0.01$	$p < 0.01$	$p = 0.4$
Population size < 10,000	560	297	3.0 $\pm$ 1.8	3 (2–4)			
Countryside	1700	1028	3.0 $\pm$ 1.8	3 (2–4)			
Population size 10,000–100,000	1333	676	3.4 $\pm$ 2.0	3 (2–4)			

SD – standard deviation

tients, respectively. The mean number of episodes of infection in medium-sized and large cities was significantly higher compared to those in small towns and villages (t-test for groups, $p < 0.01$) (Table 3).

The total number of hospitalizations was 713, which accounted for 16.2% of the children in the study group. Despite the infections, 1866 children (42.5%) did not miss a single day of attendance in educational institutions. The mean number of missed school days for children who stayed at home due to infection was 20 days, with a median of 15 days. The presence of cigarette smokers in a household significantly increased the number of missed days in nurseries/kindergartens/schools due to infection ($p < 0.01$). Children attending nurseries missed more days than those attending kindergartens and schools (Table 4).

There was a negative correlation between hospital admissions and age (Pearson's test $r = 0.09$, $p = 0.02$). Having siblings, atopic diseases, exposure to tobacco smoke, lack of vaccination, attending nurseries, and living in small towns and villages predisposed children to more frequent hospitalization (t-test for groups, $p < 0.01$) (Table 5).

DISCUSSION

To our knowledge, this is the first Polish non-interventional questionnaire study conducted in the developmental age population (represented by 4389 patients) to assess the impact of selected environmental factors and parental behaviours on the incidence of URTIs in children. The study showed that environmental factors may have an impact on both the incidence of URTIs and the treatment approach in children, particularly including the length and type of antibiotic therapy. This was confirmed by our results and the findings presented by other authors [7]. In our study, the number of episodes of infections was significantly higher in children from large municipalities, those with atopy, and those chronically exposed to tobacco smoke ($p < 0.01$) (Table 1). Similar observations were presented by Forssell *et al.* for a group of 190 children [8]. Our findings were also consistent with those of a 2015 meta-analysis of respiratory syncytial virus infections and a meta-analysis on the risk factors for community-acquired pneumonia in New Zealand [9].

TABLE 4. Number of children absent from an educational institution (nursery, kindergarten, or school) due to upper respiratory tract infections depending on selected environmental and clinical factors in the study group ($n = 4389$)

Risk factor	Absent	Non-absent	χ^2 test
Exposure to cigarette smoke	621	343	$p < 0.01$
No exposure to cigarette smoke	1902	1523	
Day-care attendance	2430	566	$p < 0.01$
No day-care attendance	93	1300	
Siblings	1197	777	$p < 0.01$
No siblings	1326	1089	
Normothermy	700	664	$p < 0.01$
Increased body temperature	1823	1202	
Antibiotic therapy	1195	709	$p < 0.01$
No antibiotics	1328	1157	
Nursery attendance	395	166	$p < 0.01$
Kindergarten attendance	1554	288	
School attendance	481	112	
Home schooling	18	319	

We also showed that having siblings was an important risk factor for respiratory infections ($p < 0.01$). This has been confirmed by other researchers [10–15]. However, studies have shown that having siblings has no influence on the severity of the disease, as confirmed in our research. Antibiotic therapy was used significantly less often in this group ($p < 0.01$). This was probably due to parental experience in dealing with mild respiratory infections and additional knowledge acquired through previous medical appointments with children. Therefore, it seems necessary to educate parents attending medical appointments due to respiratory tract infections in their children to reduce the frequency of antibiotic use [16–18].

Our observations showed that the type of educational institution attended by children significantly influenced the number of episodes of infection. Many studies have confirmed that attending a day-care facility is an important

TABLE 5. Hospitalization frequency and selected environmental and clinical factors in the study group ($n = 4389$)

Risk factors	Total number of patients	Hospitalizations	Mean $\pm$ SD	Median (Q1–Q2)	p -value	
Male gender	2281	396	0.22 $\pm$ 0.95	0 (0–0)	$p = 0.03$	
Female gender	2108	317	0.19 $\pm$ 0.51	0 (0–0)		
Siblings	1974	367	0.23 $\pm$ 0.56	0 (0–0)	$p < 0.01$	
No siblings	2415	346	0.18 $\pm$ 0.54	0 (0–0)		
Allergy	1151	381	0.43 $\pm$ 0.70	0 (0–1)	$p < 0.01$	
No allergy	3238	332	0.13 $\pm$ 0.46	0 (0–0)		
Tobacco-smoke exposure	1192	265	0.34 $\pm$ 0.68	0 (0–1)	$p < 0.01$	
No tobacco-smoke exposure	3197	448	0.15 $\pm$ 0.49	0 (0–0)		
Vaccinated	4,271	675	0.20 $\pm$ 0.54	0 (0–0)	$p < 0.01$	
Non-vaccinated	118	38	0.47 $\pm$ 0.85	0 (0–1)		
Nursery attendance	561	185	0.44 $\pm$ 0.74	0 (0–1)	$p < 0.01$	$p < 0.01$
Kindergarten attendance	1842	262	0.18 $\pm$ 0.52	0 (0–0)		
School attendance	593	60	0.11 $\pm$ 0.35	0 (0–0)		
Home schooling	593	40	0.16 $\pm$ 0.43	0 (0–0)		
Cities with a population size of < 10,000	560	119	0.25 $\pm$ 0.56	0 (0–0)	$p < 0.01$	
Cities with a population size of 10,000–100,000	1333	124	0.11 $\pm$ 0.40	0 (0–0)		
Countryside	1700	382	0.29 $\pm$ 0.65	0 (0–0)		$p < 0.01$
Cities with a population size of > 100,000	796	88	0.14 $\pm$ 0.51	0 (0–0)		

SD – standard deviation

predictor of respiratory tract infections [10–12, 14, 15, 17, 19–23]. In a study in 2017, Schuez-Havupalo *et al.* showed significantly increased rates of infections in children after 2 months of attending a nursery, which persisted throughout the attendance period without dropping to the baseline. This is undoubtedly a significant economic problem for the employers of parents with young children [5]. We showed that young children attending nurseries were more likely to develop URIs compared to preschool and school children ($p < 0.001$). This was also confirmed in other research that analysed large groups of patients [10, 11, 23, 24]. Forastiere *et al.* and von Mutius *et al.* showed that having siblings reduced the risk of atopy, which is an important risk factor for infection [12, 13]. Unfortunately, we could not confirm these observations because we did not analyse similar correlations in our study. However, we did show that the mean number of infections was significantly higher in children with confirmed atopy who had siblings ($p < 0.01$). Compulsory vaccinations for children had a significant impact on both the mean number of URIs and the hospital admissions ($p < 0.01$). This is a particularly important argument confirming the appropriateness and necessity of vaccinating children, as confirmed by Jackson *et al.* in their 2013 meta-analysis of risk factors for respiratory tract infections [7].

Although the percentage of smokers has significantly decreased in recent years, exposure to tobacco smoke remains a major health problem [25]. Many studies in large groups of patients have confirmed that the risk of respiratory tract infections (and their severity), asthma, and respiratory symptoms (such as cough, bronchial hyperreactivity, and recurrent infections) is also increased in passive smokers [26–30]. In our study, the number of episodes of URIs and antibiotic therapy were significantly higher in the group of children exposed to tobacco smoke ($p < 0.01$). The proportion of patients receiving antibiotics increased from 23.8% in children not exposed to tobacco smoke to 31.5% in those with chronic exposure. This clearly indicates an urgent need for intensive education of parents on the impact of tobacco smoke on the health of children.

The significant increase in the number of infections in urban vs. rural children ($p < 0.01$) may also be associated with air pollution, which is a major health and environmental problem. This was already known in 2005, when the World Health Organization published a European report on the relationship between poor air quality and the rates of respiratory tract infections [31, 32]. A study conducted in California in 2001 showed that air pollution and the associated increase in the rates of respiratory infections caused a 67% drop in school attendance [33].

Our study also showed that infections significantly reduced attendance rates at nurseries, kindergartens, and schools ($p < 0.01$). The increased rates of respiratory tract infections among urban children are attributable to poor air quality in Poland, which should prompt us to take rapid measures to reduce emissions. The increased incidence of infections in urban children may also result from the fact that they are more likely to attend day-care and thus are exposed to pathogens to a larger extent [34].

CONCLUSIONS

The environmental factors identified in this study had a significant impact on the behaviours of the parents/guardians of children with URTIs. They clearly indicated the involvement of social factors, including place of residence, attending day-care, having siblings, and parental knowledge concerning breastfeeding, vaccinations, and the harmful effects of tobacco smoke on their children. These factors had indirect negative economic effects on employers and the Polish economy because they significantly increased hospitalization rates and the number of days missed at work by the parents/legal guardians of children with URTIs. Therefore, ongoing parental education about the role of vaccinations and the harmful effects of tobacco smoke on children is necessary.

DISCLOSURE

The authors declare no conflict of interest.

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