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Respiratory Diseases in Children and Air Pollution – The Cost of – Illness Assessment in Ostrava City

ABSTRACT: *The article addresses the need to identify and quantify the external costs of air pollution on the health of the population, especially children. The subjects of evaluation are the respiratory illnesses acute nasopharyngitis and acute bronchitis, both of which have very high incidence in connection with air pollution. The aim of this paper is to estimate the cost of morbidity and to determine the amount of additional social costs of airway morbidity among children aged 0–15 years in Ostrava city, one of the most polluted cities in Europe, compared to the incidence of these diseases in the whole Czech Republic. Estimation of social costs is based on the Cost-Of-Illness approach, in which the total value is made up of the costs actually incurred in treating illness and in loss of productivity. Using this approach, additional costs related to the treatment of illnesses were calculated at approximately €20 million per year, which represents approximately 0.4% of Ostrava´s regional gross domestic product (GDP).*

KEYWORDS: Cost-Of-Illness, health cost, Ostrava, nasopharyngitis, bronchitis, children

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INTRODUCTION

The health impacts associated with urban pollution are often considered to be a result of industrial and technological development with observed connection between the smog situation and increased mortality (for more information, see e.g. Lipfert, 1994). The evidence of the relationship between concentrations of pollutants and their impact on human health is identified mainly on the basis of epidemiological studies. Air pollution poses risks to the population in the form of increasing mortality and morbidity rates, which arise primarily from long-term exposure to particulate matter (PM_{10}, $PM_{2,5}$) in areas exposed to traffic. These are mainly associated with the occurrence of respiratory, cardiovascular, oncological and cerebrovascular diseases.

Evidence that long-term exposure to air pollutants increases the risk of respiratory diseases has been presented in, for example, the studies by Hoek et al. (2012). A study by the American Academy of Pediatrics (Kim, 2004) confirms hat children living in areas with higher levels of pollution (especially PM_{10} and $PM_{2.5}$ particles) experience reduced lung function, respiratory disease, asthma exacerbation and so on. A European cohort study confirmed a decrease in lung function in school children aged 6–8 years (Gehring et al., 2013). In contrast, short-term changes in pollutant exposure examined by Darrow et al. (2014) in an 18-year research showed that with the increase of some air pollutants (especially $PM_{2.5}$), the number of visits to emergency services due to bronchitis, pneumonia and upper airway inflammations increased. Short-term exposure to air pollution was associated with increasing risk of hospital utilisation for chronic respiratory disieases (chronic obstructive pulmonary diseases and asthma) in children (Zhang et al., 2016).

In addition to the generally excessive concentration of pollutants in the air, research into the effects of air pollution is also aimed at examining the impacts from various sources of pollution, particularly because of the increasing importance given for the air pollution caused by transport, industry and biomass combustion at home. Emissions from these sources lead, for example, according to Laumbach and Kipen (2012), to personal exposure to complex substances that change rapidly in space and time and vary according to various factors such as distance from the source, ventilation rate and so on. Emissions from local fireplaces cause predominantly acute lower respiratory tract infections and transport emissions are the major contributors to asthma and allergies. These results have been confirmed, for example, by the followings studies. The conclusions of Schultz et al. (2012) have shown that exposure to air pollution from childhood affects the lung function in children under 8 years of age, especially those who are sensitive to common inhalation or food allergens. Results of a study (McConnell et al., 2010) conducted on nearly 2,500 children in California have shown that the risk of developing asthma disease increases with increasing exposure to traffic pollution (children who live or attend

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school near traffic-exposed locations are more likely to suffer from asthma). An increased risk of atopic and allergic diseases has been confirmed in children 4–6 years of age who live near the roads exposed to traffic (Morgenstern et al., 2008). The effects of heavy industry air pollution on the lung function and respiratory symptoms in school children were examined by Bergstra et al. (2018). The results of the study showed that exposure to $PM_{2.5}$ and nitorgen oxides from the industry was associated with decreased lung function and increased incidence of dry cough in children.

Decrease in air quality leads to an increased incidence of respiratory diseases, allergies and asthma among children. This is reported in particular by a research that focused on children's morbidity caused by air pollution in Ostrava. The results (Dostál et al., 2011, 2013a, 2013b) showed that the group of respiratory diseases, in particular, acute nasopharyngitis, acute bronchitis and acute tonsillitis, contributed to the overall morbidity. Out of the allergic diseases, asthma, atopic eczema and allergic rhinitis had the highest prevalence (Líbalová et al., 2011). The relationship between air pollution and respiratory and allergic diseases has also been confirmed by other studies conducted in Ostrava (Fletcher et al., 2004; Hoek et al., 2012; Rychlíková et al., 2010; Šrám et al., 2013b; Velická et al., 2015).

Thus, the health impacts from environmental pollution have already been proven by the above-mentioned mostly epidemiological studies. However, there is still a limited number of studies reflecting on the economic costs of such pollution. Information is especially lacking in the area of economic evaluation of the impact of a damaged environment on children. Given this shortcoming, it is very difficult to assess the impact of existing environmental or health policies. It is, therefore, necessary, especially with regard to the existing specific, socio-demographic, geographic and, above all, health conditions, to fill this gap. Protecting human health is the primary objective of environmental policy, and economic health assessment can help policymakers assess the relative value of alternative measures (Dickie and List, 2006), especially in the Czech Republic, where there are very few studies that quantify and recognise the impacts of the environment on health.

Air pollution is a major problem, particularly for large cities and industrial agglomerations, affecting a significant proportion of the population. One of the most critical situations, according to measurements of the Czech Hydrometeorological Institute (CHMI, 2018), not only in the Czech Republic but throughout the whole Europe, is in the Ostrava/Karviná/Frýdek-Místek region, which this study focuses on. Permanent exceedance of the emission limits of certain pollutants in this area has a very significant impact on the health of the population, especially on children, who cannot sufficiently withstand external influences. In addition to the problem of negative health effects, additional costs are incurred, which in turn puts an excessive burden on public budgets and households.

Air pollution is a serious threat, especially to children, whose developing body is very sensitive to external influences and who are at risk of getting affected by various diseases (e.g. Kim, 2004; Šrám et al., 2013a). The aim of the national health policy is to improve the state of health of the population. Public health research and monitoring health data help to identify the current health status and its problems. From an economic point of view, decisions should be supported by information on costs, risks and health outcomes. However, understanding the relevant ‚production functions' in the healthcare sector is also very limited. So far, we know very little about the quantified relationship between inputs (time costs, medications) and outcomes, that is, the improvement of health (Carter, 1994).

This article studies the relationship between increased sickness rate from air pollution and the additional social cost expressed in monetary units. We pay special attention to the cost items concerning the treatment of acute nasopharyngitis and acute bronchitis, that is, respiratory illnesses associated with air pollution, which we evaluate using the Cost-Of-Illness (COI) method. The aim of this study is to estimate the cost of morbidity and to determine the amount of additional social costs of airway morbidity among children 0–15 years located in Ostrava city.

The article is structured as follows: the first subchapter provides a general description of the COI method, followed by its methodology; the second part contains an evaluation of the costs of the respiratory diseases analysed in the context of the Czech Republic; the results are then discussed, including the limitations of the study and the recommendations for public policy.

MATERIALS AND METHODS

The main goal of the article is to identify the costs related to the treatment of acute nasopharyngitis and acute bronchitis, that is, airway diseases associated with air pollution in Ostrava city, based on the COI method and to find out the average direct and indirect costs. A secondary goal is to compare the observed costs in Ostrava and the Czech Republic based on the occurrence of morbidity. The analysis then focuses on finding out the value of the social costs of morbidity resulting from air pollution in Ostrava among children aged 0–15.

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Cost-Of-Illness

COI is a general method that allows the cost of a wide range of health conditions to be assessed in different geographic areas (Larg and Moss, 2011). Thus, COI is a form of economic assessment in healthcare. The main objective is to assess the economic burden on the society in terms of consumption of resources in healthcare and production losses (Tarricone, 2006). COI is a descriptive analysis assessing the economic burden of health problems. All impacts are translated into monetary values, where possible, resulting in quantified costs. The aim of the method is to determine the overall economic burden of various health problems (Larg and Moss, 2011).

The traditional approach of COI involves direct costs, which mainly consist of healthcare costs, and indirect costs (productivity losses) related to morbidity and mortality. Direct costs can be divided into two categories: health costs resulting from illness and the associated ‚non-health‘ costs (Rice, 2000). The first category includes expenditure on medical care, including expenditure on diagnostics, treatment, rehabilitation and so on. The second category, on the other hand, is related to the consumption of resources that are not directly linked to the healthcare. They include, for example, transport expenses, household expenses, informal care and so on (Jo, 2014). This depends on the subject and purpose of the study as to which specific costs will be included in the analysis.

The traditional indirect cost pricing approach is based on the human capital approach (HCA) and it estimates the value of the potential loss of production (wages) due to the illness. In COI studies, the term indirect costs is sometimes replaced by the term loss of productivity. According to neoclassical economic theory, productivity is based on the function of production, where the resulting product is a function of inputed capital, labour and technology. Productivity is then a measure of output per unit of input (Pilat and Schreyer, 2001). However, in the context of the COI study, the loss of productivity means the absence of employment corresponding to the loss of social production, including the loss of income and loss of unpaid production. In some studies, loss of leisure time is also included in the assessment. The value of the loss of productivity is thus equal to the value of the loss of output. Both methods then use the wage rate on the market as a proxy for the marginal loss of output at the company level (Zhang et al., 2011).

In the context of the COI study, loss of productivity means particularly, absence from work, including corresponding losses of production. The value of the loss of productivity is thus equal to the value of the loss of output. The HCA assesses the burden of sickness as the costs of lost opportunities measured as productivity loss in terms of expected future income (Tarricone, 2006). It is assumed that the value of productivity loss from a social perspective should be measured as the present value of lost time based on market wage, which is approximately equal to the marginal revenue product in a competitive labour market (Zhang et al., 2011).

When assessing indirect costs, it is also necessary to take into account the fact that some individuals are not participating in the labour market. These may be, for example, homekeepers or people on parental leave. Rice (1967) recommends that these people should not be left out of the indirect cost assessment, even if their economic value is not included in the national accounts. In this respect, there are two possible approaches – opportunity cost and market cost estimates (Drummond et al., 2015; Murphy, 1978). Market costs are then estimated on the basis of wage rates similar to employment in the market, and occasional costs are based on the assumption that the economic value of unpaid production is at least the same as that person would have on the market (Landefeld and McCulla, 2000). Despite all the different recommendations regarding productivity loss, there is still no detailed methodological guidance on how productivity loss should be estimated (Zhang et al., 2011).

The COI method is quite commonly used in studies calculating morbidity costs for various diagnoses (Akobundu et al., 2006), mainly in the calculation of average and total costs, and also in the analysis of individual cost components. COI studies were also used for calculating the cost of respiratory diseases in children. Alebrini and Krupnick (2000) estimated by COI the damage caused by respiratory symptoms associated with air pollution in Taiwan. Srivsatava and Kumar (2002) calculated the direct and indirect costs of bronchitis in Mumbai. Quah and Boon (2003) estimated the costs of lower respiratory tract disease in Singapore, and Enserink et al. (2014) estimated the cost of illness for influenza in children in the Netherlands.

Methodology

The assessment of children‘s health in this article focuses only on the two most common respiratory illnesses based on research on their prevalence among children in Ostrava (Dostál et al., 2011): acute nasopharyngitis (ICD-10 code J00) and acute bronchitis (MKN-10 code J20). The identification of costs is based on determining the usual course of the illness without complications. The

Tab. 1: Description of the course of the illnesses used in the questionnaire survey

	Nasopharyngitis	Bronchitis
Description	• Mucosal infection that does not affect the tonsils • Uncomplicated course not requiring antibiotic treatment	• Viral or bacterial infection • Antibiotic treatment required
Symptoms	• The child has a wet cough • Has a cold • Has a high temperature • Is tired, has a headache • Has enlarged and painful lymph nodes on the neck	• The child has a strong, continuous cough • Difficulty breathing, wheezing • First, the child has a dry cough, then coughs up mucous • Has a headache • Has chest pain • Has fever accompanied by chills
Restrictions	• The child does not attend kindergarten/school for a maximum of 5 days • Takes paracetamol, ibuprofen, and cough and cold medications • The mother or another relative is at home for 5 days	• The child takes antibiotics and other supportive medications • The child must see a doctor or go to a hospital • The mother or another close person is at home with the child for at least 10 days
Duration	• High temperature, difficulty breathing and other symptoms last for 5 days	• The child is at home for 10 days and does not go to school, and after that does not attend physical education classes for at least 14 days

Source: Ščasný et al. (2005), further modified by the author.

description comes from Ščasný et al. (2005) and is further modified with other parameters supplemented from consultation with a general practitioner for children and adolescents. The description of the illnesses is presented in Table 1.

Identification of costs is based on the identification of treatment procedures and children's consumption of medication based on their age categories in consultation with paediatricians for children and adolescents and allergists. Thus, by using the COI method (COI = direct costs + indirect costs) in this article, the direct and indirect costs of a model course of treatment of illnesses are identified and the estimated costs are expressed from a social perspective; they include all costs in terms of the healthcare system, the national budget, households and employers. The following formulas give a clear overview of how social costs are calculated with the COI:

Direct costs = costs of treatment (=costs of health insurance companies + private surcharges for healthcare) + costs of medicines (=costs of health insurance companies + private surcharges for medicines)

Indirect costs = sick days × eight working hours (day) × full hourly labour costs + sick days × 0.6 × (reduced daily assessment base for mothers)

Direct cost

Direct costs consist of expenditures related to healthcare. In the Czech Republic, they are based primarily on the reimbursement decrees of the Ministry of Health and information on reimbursement of medicines by the State Institute for Drug Control. These costs can be divided into public and private expenditure. Public expenditures are mainly related to the expenditures of health insurance companies, which are part of the public health insurance. Private costs are related to the household expenditures incurred for supplementary payments for healthcare not covered by the health insurance company.

The first step in the quantification of direct costs is to determine the corresponding medical interventions in accordance with Decree No. 143/2018 Coll., which issues a list of medical interventions with point values, and subsequently to multiply the value of these points in CZK in accordance with Decree No. 348/2016 Coll. As the general practitioners for children and adolescents are remunerated by a combined system of capitation/fee-for-service payments, not all interventions are covered by a reimbursement payment, but the vast majority of them are included in the capitation component. The capitation component is not taken into account in the calculation of direct costs because it applies to each registered patient regardless of the number of visits to the health facility. Medicines were selected for each illness in consultation with doctors, so that they were always the most commonly prescribed

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drugs. The size of the package was chosen to match the length of use of the medicines in order to avoid overestimating the costs. The cost of the whole package is included in the estimation of direct costs, as recommended, for example, by Rozan (2001), as this reflects the total expenditure, that is, the real cost.

Indirect cost

Determination of indirect costs (loss of productivity) is based on the traditional approach of estimating the indirect costs based on the HCA, which estimates the social loss resulting from absence from work due to caring for a sick child. We expressed the total loss from the social perspective by calculating the sum of two cost components including the full hourly labour costs and social loss in the form of insurance benefits for sickness.

Total hourly labour costs take into account the average wage for work performed, the statutory insurance paid by the employer and employee, and some other components. Data from the Czech Statistical Office on hourly labour costs are used. Employers‘ costs consist of a possible loss of production or additional costs for replacement of the employee. Public costs include the loss of additional funds in connection with the loss of income from compulsory social insurance payments. The value of hourly labour costs is adjusted based on the values for women in the Moravian-Silesian Region according to the classification of economic activities in the Czech Republic. Subsequently, the average daily income is calculated assuming eight working hours per day.

The total loss of productivity is calculated by multiplying the average daily income by the length of absence from work, which is given by the average duration of illness according to the model (standard) course of the illness. As it is about the morbidity of children, the loss of productivity of mothers is considered, that is, only of those women who have children, due to caring for a sick child. Although some women do not actually lose their wages due to temporary status outside the labour market (maternity/parental leave), they are also included in the productivity loss assessment as recommended by Rice (1967), using the market cost method, an estimate based on the salaries of similar jobs in the market.

Another component of the loss of productivity is **sickness insurance (carers' benefits**), which is an important part of the total social loss due to the child's illness. The amount of carers' benefit is calculated from the average gross wages according to the Czech Statistical Office. Public costs include losses connected to carers' benefits paid by the Czech Social Security Administration. However, the carer's allowance is not paid to all people, but is intended primarily for the employees participating in sickness insurance. In order to estimate the costs as accurately as possible, the amount of benefits is calculated separately for the mothers with children aged 0–3, that is, the maximum length of time for which parental allowance is given, and for other mothers of children aged 4–15. The value is adjusted again to the average gross wage for women in the Moravian-Silesian Region based on CZ-NACE. The amount for the care of a sick relative is paid from the first day of treatment at 60% of the daily assessment base.

The overall assessment of indirect costs does not take into account some additional costs that would require further economic analysis, such as travel costs and leisure time value, and other potential costs that cannot be attributed to individual diseases, such as hospital infrastructure, outpatient care, health programmes. For these reasons, it is rather the lower limit of the average cost estimate. It is also necessary to point out that this is a predetermined model course of the disease, which should express the classical, usual course of the disease. Thus, the model does not take into account complications, comorbidities and so on.

Calculating the social costs of respiratory illnesses in Ostrava city

The estimate of social costs is based on a comparison of average morbidity prevalence in Ostrava and the Czech Republic without further statistical analysis extracting the effect of air pollution. The comparison of morbidity prevalence is based on monitoring of the health of the population in relation to the environment in the Moravian-Silesian Region (National Institute of Public Health [NIPH], 2016, 2019) and the Czech Republic (NIPH, 2017), in which the incidence of respiratory illnesses and allergies in children was monitored in 2015. The research is focused on the territorial district of the city of Ostrava. In this study, the city is divided into two areas reflecting the air quality – east and west (Figure 1). The east is an area where the largest industrial sources are located and is characterised by the worst air quality. This area is also characterised by the highest concentrations of NO_2, which corresponds to the high traffic intensity. The west is characterised by relatively better air quality.

Since no statistical significance in differences in morbidity was found in individual age categories in the vast majority of cases, the same prevalence of the disease is assumed for all age groups. Information about nasopharyngitis and bronchitis is provided by the

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Fig. 1: Division of Ostrava into two parts.

Source: Own processing based on NIPH, 2016.

parents. Frequent, recurrent nasopharyngitis at least five times a year and frequent, repeated acute bronchitis more than three times a year were considered. Table 2 shows the prevalence rates in Ostrava and the Czech Republic.

RESULTS AND DISCUSSION

In this section, the direct and indirect costs associated with the treatment of acute nasopharyngitis and acute bronchitis are calculated. The costs are calculated per one course of the illness from the social perspective, that is, they include all costs in terms of the healthcare system, state budget, households and employers.

Acute nasopharyngitis

Direct costs are based on the determination of treatment interventions and drug consumption. As it is a relatively standard and not very demanding examination, the doctor usually performs an examination with a stethoscope to find a result by listening, a palpation examination of the cervical nodes or a throat swab, and less often for persistent complaints, there may be a nose swab or an otoscopy for pain in the ears.

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Tab. 2: Prevalence of respiratory diseases in Ostrava and the Czech Republic

Region	Nasopharyngitis (%)	Bronchitis (%)
Ostrava – west	28.13	17.89
Ostrava – east	30.56	18.75
Czech Republic	18.82	8.67
Difference between west Ostrava and the Czech Republic	9.31	9.22
Difference between east Ostrava and the Czech Republic	11.74	10.08

Note: These are simple percentages.
Source: Own processing based on NIPH, 2019.

Tab. 3: COI – direct costs per case of acute nasopharyngitis (EUR, 2017*)

	Medical procedures	Medication		Total
	Health insurance costs	Health insurance costs	Household costs	Total costs per case
Age 0–10	€2.1	€0	€14.4	€16.5
Age 11–15	€2.1	€0	€11.3	€13.4

Source: Own processing based on SÚKL (2018), Ministry of Health (2018), Decree 348/2016 Coll.
Key: COI, Cost-Of-Illness.
* 26.33 CZK/EUR; average exchange rate Czech National Bank, 2017.

For these reasons, only the basic cultivation examinations of material from the respiratory tract are included in the estimation of specially reimbursed operations (this is a reimbursement to the laboratory, but it is still a payment under public health resources), which has a point value of 77 and an overall cost of €2.1. Direct health costs for households are not relevant. There is one check-up included in the capitation payment. Treatment of this illness does not require further special outpatient care; it mainly involves the use of medicines. Usually prescribed are nasal drops (Nasivin), cough drops or syrup (Mucosolvan) and temperature-reducing drugs (Nurofen). The doctor also recommends the use of serum to cleanse the nasal mucosa (Vincentka mineral water).

Table 3 shows the total direct costs of the treatment of the illness, including the public costs, or rather the health insurance costs and the household costs, by age category.

In order to express indirect costs, in the first step, I started by expressing the loss of productivity based on full hourly labour costs separately for employees or self-employed people at the amount of €8.9/hour (average of all jobs according to CZ-NACE) and for parents on maternity or parental leave at €9.0/hour (CZ-NACE health and social work; including the women temporarily out of the labour market, as recommended by Rice, 1967).

The estimated gross average wage of €949 for women in the Moravian-Silesian Region was used to estimate the average amount of carer's benefit. A calculator for benefits calculation was used (MLSA, 2018). The amount of carer's allowance for 1 day is €16.9 at the given average wage (Table 4).

Table 5 shows the total social costs per case of acute nasopharyngitis by age category and the type and cost bearer. The results clearly show that, with increasing age, the total social costs increase.

Acute bronchitis

Direct costs include medical care and medicines. Diagnosis of this illness includes examination with a stethoscope to find a result by listening, a palpation examination of the cervical nodes and a swab from the throat and nose. To differentiate between a viral and a bacterial infection, the physician performs a C-reactive protein (CRP) test or uses a blood sample from a vein to determine the blood count.

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Tab. 4: Loss of productivity in acute nasopharyngitis based on the individual course of the illness from the social perspective (EUR, 2017)

Loss of productivity based on labour costs			Loss of productivity based on sickness insurance benefits			Total loss of productivity per case	
No. of working days	Age 0–3	Age 4–15	No. of calendar days	Age 0–3	Age 4–15	Age 0–3	Age 4–15
5	€359.1	€356.0	7	€0	€118.0	€359.1	€474

Source: Own processing.

Tab. 5: Social costs per case of acute nasopharyngitis (EUR, 2017)

	COI – direct costs		COI – indirect costs		Total social costs per case
Age	**Health insurance costs**	**Household costs**	**Work-related costs**	**Sickness insurance benefits**	
0	€2.1	€14.4	€359.1	€0	€ 375.6
1–3	€2.1	€14.4	€359.1	€0	€375.6
4–5	€2.1	€14.4	€356.0	€118.0	€490.5
6–10	€2.1	€14.4	€356.0	€118.0	€490.5
11–15	€2.1	€11.3	€356.0	€118.0	€487.4

Source: Own processing.
Key: COI, Cost-Of-Illness.

To estimate the cost of the classic course of the illness, which includes a fee-for-service payment, the calculation includes a throat swab (77 points, €2.1), a nose swab (77 points, €2.1) and a CRP test (103 points, €4.2). The direct medical costs for households are not relevant. There are one or two check-ups included in the capitation payment.

Treatment of this illness does not require further special outpatient care; it mainly includes the use of medicines. Antibiotics (Augmentin DUO), antibiotic nasal drops (Pamycon), cough syrup (Ambrobene) and symptom relief (Fenistil) and temperature-reducing drugs (Nurofen) are usually prescribed. Probiotics (Lactobacilli – 15 tablets) should be taken together with antibiotics. We took into consideration the most commonly used drugs for one course of the disease. Table 6 includes the calculation of the total direct costs for one case of acute bronchitis. In addition to the costs of health insurance, the total costs also include the household costs of the purchase of medicines.

Calculation of indirect costs from the social perspective for bronchitis was done in the same way as for nasopharyngitis. The results are shown in Table 7.

Table 8 shows the social costs of treating one case of acute bronchitis based on age. As with acute nasopharyngitis, the cost of morbidity increases with age. Again, indirect costs make up the greatest share, accounting for up to 95% of the total costs.

Estimated additional social costs of respiratory illnesses in Ostrava city

We found out how much the total social costs of treatment of the monitored respiratory illnesses in Ostrava are higher compared to the Czech average. The calculation was based on the difference in the prevalence of morbidity in individual areas of Ostrava and the Czech Republic according to the NIPH (2019) and the number of inhabitants younger than 15 in individual districts of Ostrava (Ostrava, 2018). Based on these data, the number of affected people aged 15 and over was estimated, which can be considered to be a rough estimate of increased morbidity due to air pollution. In order to estimate the overall incidence of morbidity, the number of children was multiplied by 5 for acute nasopharyngitis and 3 for acute bronchitis, so as to estimate the incidence of the illness in

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Tab. 6: COI – direct costs per case of acute bronchitis (EUR, 2017)

	Medical procedures	Medication		Total
	Health insurance costs	Health insurance costs	Household costs	Total costs per case
Age 0–10	€8.4	€6.3	€20.5	€35.2
Age 11–15	€8.4	€6.3	€17.4	€33.2

Source: Own processing according to SÚKL (2018), Ministry of Health (2018), Decree 348/2016 Coll.
Key: COI, Cost-Of-Illness.

Tab. 7: Loss of productivity for acute bronchitis based on the individual course of the illness from the social perspective (EUR, 2017)

Loss of productivity based on labour costs			Loss of productivity based on sickness insurance benefits			Total loss of productivityper case	
Number of working days	Age 0–3	Age 4–15	Number of calendar days	Age 0–3	Age 4–15	Age 0–3	Age 4–15
8	€574.6	€569.5	10	€0	€168.6	€574.6	€738.1

Source: Own processing.

Tab. 8: Social costs per one case of acute bronchitis (EUR, 2017)

	COI – direct costs		COI – indirect costs		Total social costs per case
Age	Health insurance costs	Household costs	Work-related costs	Sickness insurance benefits	
0	€14.7	€20.5	€574.6	€0	€609.8
1–3	€14.7	€20.5	€574.6	€0	€609.8
4–5	€14.7	€20.5	€569.5	€168.6	€773.3
6–10	€14.7	€20.5	€569.5	€168.6	€773.3
11–15	€14.7	€17.4	€569.5	€168.6	€770.2

Source: Own processing.
Key: COI, Cost-Of-Illness.

1 year. The average social costs for children were obtained by a weighted average, taking into account the total costs based on age category and the number of inhabitants in the Ostrava-město District.

In this way, a cost of €460.50 for the treatment of one case of acute nasopharyngitis and €731 for the treatment of one case of acute bronchitis was calculated. Estimates of additional social costs for the treatment of acute bronchitis due to the decreased air quality in the Czech Republic obtained from a comparison of the prevalence of the disease in individual parts of Ostrava and the Czech Republic are shown in Table 9.

The aggregate results yielded an overall estimate of almost €20 million for the annual social costs towards acute nasopharyngitis and acute bronchitis among children under 15 years of age in Ostrava, which represents approximately 0.4% of Ostrava´s gross domestic product (GDP). Although the cost of one course of the disease is higher for acute bronchitis (i.e. a more severe illness), the total additional costs are higher for acute nasopharyngitis due to higher prevalence of the illness per year. The results also make it clear that the overwhelming majority of the total costs is from indirect costs, including mainly financial loss due to absence at work.

From a social point of view, it is very important to look at the individual cost factors in terms of the ratio of the burden on the public sector and households or the impact of the child‘s age on the cost. Interesting knowledge can then bring differences of the amount and proportion of costs in comparison between individual diseases.

Tab. 9: Social costs per year associated with the incidence of acute nasopharyngitis and acute bronchitis in Ostrava due to diminished air quality (EUR, 2017)

Region	Nasopharyngitis	Bronchitis
Ostrava – west	€2,321,773	€2,189,623
Ostrava – east	€7,926,359	€6,480,889
Total	*€10,248,132*	*€8,670,512*

Source: Own processing.

The cost distribution presented in Table 8 shows the high share of indirect costs. This represents a burden on the state in the form of lower social security contributions and, on the other hand, higher costs of nursing benefits. For employers, these are costs associated with the loss of production and higher costs of employee representation. In the case of households, the costs represent a real loss of wages of approximately €20 net of nursing benefits. For nasopharyngitis and bronchitis, the costs are not age dependent. Diagnosis includes identical examinations for children of all ages. While drug consumption may increase with increasing age of children, the costs always involve purchasing the entire drug package.

Comparison with the results of other studies using the COI method to calculate morbidity costs is quite problematic, given the broad generality of the method, and hence, often different procedures for calculating the total value. Another problem is the calculation of costs in the national context, as in other countries the reimbursement for healthcare is different. The difficulty in comparing is also due to different data collection or the inclusion of other variables. Carabin et al. (1999) calculated the direct and indirect costs of treating common infections (common cold) in toddlers aged 18–36 months from the perspective of parents and society in Quebec, Canada. Direct costs were €39.7 (in prices 2017[1]) for medication and doctor visits and indirect costs were €171.1 (in prices 2017), including financial loss (including opportunity costs). The results clearly showed a high proportion of indirect costs, which accounted for 81% of the total costs. Fendrik et al. (2003) estimated the economic impact of viral respiratory tract infection (common cold) in the adult and paediatric population in the United States using the COI method. Their results showed that direct costs are on average 45% and indirect costs 55% of the total annual cost of treatment. Weissflog et al. (2001) carried out a disease cost study to assess the economic burden of these disorders in Germany. Thus, direct costs represented only 22% of the total estimated costs. In the Czech Republic, the cost of treating mild and severe bronchitis for a hypothetical patient at age 8 was calculated (Ščasný et al., 2006). The average cost of medical interventions was estimated at €8.5 (in prices 2017) for light bronchitis and €20.1 for severe bronchitis. In this case, however, the cap-off payment was not taken into account, which led to an overestimation of health interventions. The total cost of medicines was estimated at €4.7 for the first and €12.6 for the second disease. The productivity loss per day was determined on the basis of a questionnaire survey of €13.3 (€212 for 5 days). However, it was only an estimate of the amount the parents would have lost due to caring for a sick child.

Using the COI method, both the direct costs of illness management and the indirect costs associated with loss of productivity due to parental care for a sick child were identified from a social perspective, making the complete analysis useful, for example, in Cost–Benefit Analysis (Frew, 2010), Cost-Effectiveness Analysis (Sanders et al., 2016) or Cost-Utility Analysis (Luyten et al., 2016), which measure the benefits and effectiveness of the resources spent. Such comprehensive studies provide the most relevant evidence for decision-making in public policies (Segel, 2006; Shepard, 1999). Thus, the COI studies help to assess the impact of morbidity on individuals, insurance companies, public health programmes and employers (Finkelstein et al., 2003; Vandenplas et al., 2018) and can then help correctly allocate investment in clinical sickness research, set priorities for prevention and so on (Roubík, 2011). Although the COI study has a more limited role in decision-making than these cost analyses, it will provide data for the statistical model to assess the consequences of the given illnesses. This information can be very useful for political decisions in the absence of sufficient information on potential treatment and its cost (Lopéz-Bastida, 2006).

However, this approach also has some limits. Regarding the overall methodological conception of COI, the course and treatment of the analysed diseases are based on a model approach that takes into account the standard uncomplicated course of the disease

1 Monetary estimates were also translated into prices based on the purchasing power parity and the harmonised index of consumer prices.

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without the need for hospitalisation and other possible comorbidities. Another limit of the estimation is the exclusion of some types of non-medical costs directly related to treatment, which include expenditure on research, education, construction, administration and so on. These costs are often omitted from COI studies because of the difficulty, or rather the inability, to assign partial costs to individual illnesses. Another reason is due to the fact that some expenses in one period are not necessarily associated with the particular illness in that period. For example, the equipment built, spending on research or training funded in 1 year will only bring benefits in the years to come (Hodgson and Meiners, 1982). Concerning the expression of costs by the COI method, the amount was expressed by payments through the reimbursement system. Although the scores are based on the average cost of treatment, they do not reflect the total actual cost. Rather, the resulting costs can be considered a conservative estimate and a lower limit of the actual costs (e.g. Ried, 1996). Nor can the costs identified be directly considered as potential savings from prevention of illness, as, for example, it is not possible to prevent all diseases, and thus, the total costs will not be eliminated; even with partial prevention, it will still be necessary to treat patients who are ill. The results of the COI study do not even provide any data on prevention, and in fact, the cost of prevention may be higher than the cost of preventing illness (Byford et al., 2000).

CONCLUSION AND RECOMMENDATIONS FOR PUBLIC POLICY

This study has brought new knowledge in the field of assessment of the social costs of morbidity in specific conditions in the Czech Republic. Using the COI method, both the direct costs of treating the disease and the indirect costs in terms of loss of productivity due to parents caring for a sick child were identified from a social perspective. The cost of treating was estimated at €460.5 for one acute nasopharyngitis and €731.0 for one acute bronchitis. An estimate of the additional social costs due to the poor air quality in Ostrava city was at nearly €20 million per year for children aged 0–15.

The COI study showed an upward trend in overall costs with the degree of disease severity. The same trend was also seen in relation to the child‘s age. Indirect costs accounted for the largest share of total costs. This is a burden both for the public sector (health insurance system and the state budget) and for households, which bear the cost of losing their income from work. These results are in accordance with other foreign studies (e.g. Carabin et al., 1999; Ungar and Coyte, 2001).

The values obtained using the COI method express monetary outcome as an estimate of the overall burden of a given illness on the society, which may be a useful aid in health policymaking (Byford et al., 2000). Thus, the meaning of the COI method is to calculate the cost of morbidity in order to evaluate healthcare problems and to show how to distribute material resources and healthcare. The aim of the public or health policy is to reduce the unwanted effects of these illnesses on patients, the healthcare system and the society (Lopéz-Bastida, 2006), while the main benefits of conducting sickness cost studies are the following:

- monetary expression of the dimension of illness;
- justification and assessment of intervention programmes;
- allocation of research resources;
- basis for policy planning in relation to prevention and new initiatives and
- provision of an economic framework for evaluation of the programmes.

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