ENVIRONMENTAL AND SOCIOECONOMIC HEALTH INEQUALITIES: A REVIEW AND AN EXAMPLE OF THE INDUSTRIAL OSTRAVA REGION

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SUMMARY

Background and Aim: According to the World Health Organization (WHO) more than 2 million premature deaths and 7 million of total deaths each year can be attributed to the effects of air pollution. The contribution of air pollution to the health status of population is estimated to be about 20%. Health is largely determined by factors outside the reach of healthcare sector, including low income, unemployment, poor environment, poor education, and substandard housing. The aim of the paper was to review a current knowledge of relationships among air pollution, socioeconomic health inequalities, socio-spatial differentiation, and environmental inequity. The relationships were demonstrated on an example of the Ostrava region. Also basic approaches to health valuation were reviewed.

Results: Social differences are reasons both for health inequalities and spatial patterns of unprivileged area housing. In urban environments with poor air quality there is also a large concentration of low income residents. Less affluent population groups are more often affected by inadequate housing conditions including second-hand smoking and higher environmental burden in their residential neighbourhoods. Environmental injustice is highly correlated with other factors that link poverty with poor health, including inadequate access to medical and preventive care, lack of availability of healthful food, lack of safe play spaces for children, absence of good jobs, crime, and violence.

Conclusions: The theoretical background and also results of the studies brought evidence that population health is affected by both socioeconomic and environmental inequalities. Air pollution is unevenly distributed in Ostrava and is related to distribution of socially disadvantaged environment and social exclusion as well.

Key words: socioeconomic health inequalities, socio-spatial differentiation, environmental inequity, health valuation, Ostrava region

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INTRODUCTION

According to the World Health Organization (WHO) clean air is considered to be a basic requirement of human health and well-being. However, air pollution continues to pose a significant threat to health worldwide. According to the WHO assessment of the burden of disease due to air pollution, more than 2 million premature deaths each year can be attributed to the effects of urban outdoor air pollution and indoor air pollution (1). The most recent WHO website news reported total estimates of 7 million air pollution related deaths in 2012. By reducing air pollution levels, countries can reduce the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma (2).

Despite the serious health harms, contribution of air pollution to the overall health of population is estimated to be around 20%. Other factors affecting health status are genetic predisposition and health care (10–15%) and the largest impact (about 50%) is ascribed to life style (3).

Health is largely determined by factors outside the reach of healthcare sector, including low income, unemployment, poor environment, poor education, and substandard housing (4).

A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions of the world in the year 2010 (5) was based on the methods of estimated cause-specific deaths (YLL – years of life lost) and disability-adjusted life years (DALYs – sum of years lived with disability). In 2010, the three leading risk factors for global disease burden were high blood pressure (7.0% of global DALYs), tobacco smoking including second-hand smoke (6.3%), and household air pollution from solid fuels – 4.3% (5). New evidence has led to changes in the magnitude of key risks including ambient particulate matter pollution (5).

Socioeconomic Health Inequalities

In all countries with available data, there are significant differences in health between socioeconomic groups. People with lower levels of education, occupation and/or income tend to have systematically higher morbidity and mortality rates (6). The health differences are based on genetic and constitutional variations, age and chance also plays a role. In contrary, inequalities in health mean removable or modifiable differences of health status between population groups within countries and between countries. These inequalities are based on differences of social and economic conditions that affect lives of people and determine their risk of disease and also ways how to prevent such diseases and how to treat them (7). The interaction between individual and socioeconomic determinants of health is presented in different ways as shown e.g. in the Fig. 1 and Fig. 2.

Three distinguishing features, when combined, turn differences in health into social inequities in health. They are systematic (not randomly distributed across the population), socially produced (and therefore modifiable) and unfair (in Europe fairness is linked to human rights) (7). Mortality and morbidity increase with declining social position and this social pattern of disease is universal (7).

Summing up briefly, social inequities in health are directly or indirectly generated by social, economic and environmental factors and structurally influenced lifestyles. These determinants of social inequities are all amenable to change (7) and are also called socioeconomic determinants of health (8).

Socio-spatial Differentiation

The uneven distribution of population in an area indicates socio-spatial differences (9).

Different living conditions in specific types of environments can lead to disadvantaged population groups. The spatial patterns

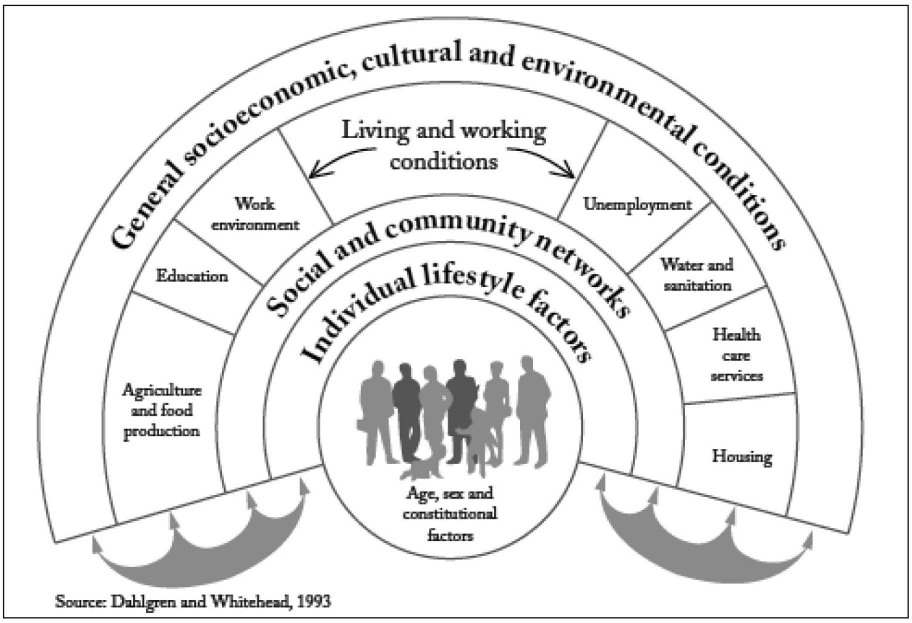

Fig. 1. The "rainbow" model of social determinants of health. Reprinted from Dahlgren G, Whitehead M, 2006 (33).

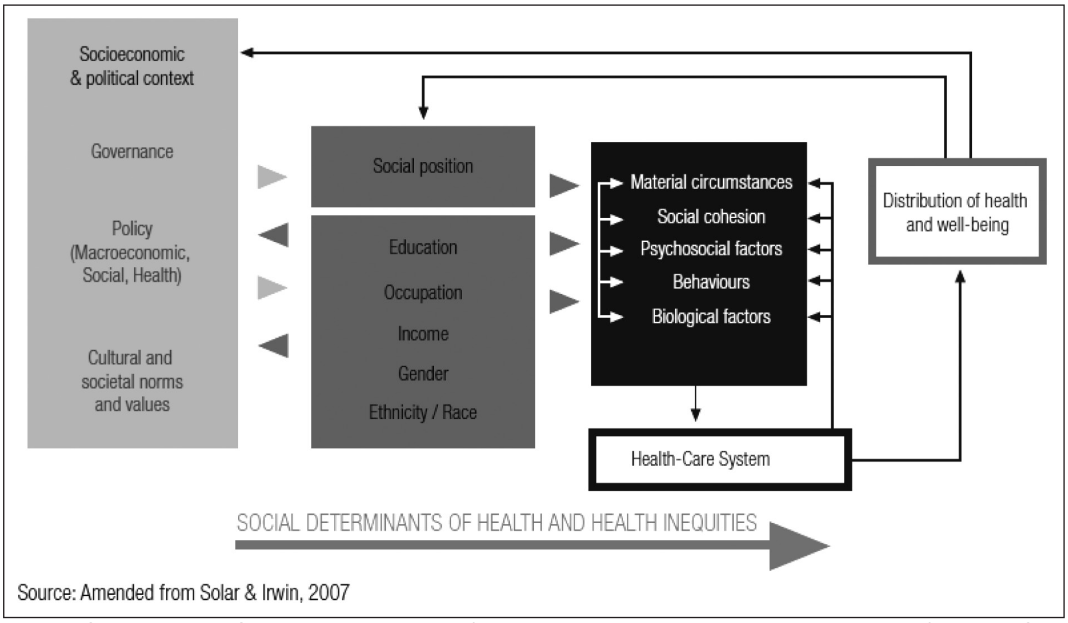

Fig. 2. Comission on Social Determinants of Health conceptual Framework. Reprinted from WHO 2008 (39).

of social differences are based on interaction between socioeconomic status (SES) of population and residential preferences.

The sources of industrial air pollution are usually situated in relatively unprivileged areas that are characterized by poor housing standards and high unemployment. On the other hand people with higher levels of education living in better conditions are more aware of these risks and try to avoid them (10).

In urban environments with poor air quality there are the large concentrations of low income residents, therefore, urban air pollution became a significant international environmental justice concern (11). These population groups often have unhealthy housing and significant exposures to indoor air pollution as well and often have higher prevalence rates of diseases such as asthma that are adversely affected by air pollution (11).

Air Pollution

Risk factor quantification is a powerful and compelling tool to support calls for policy action to improve health. Of the seven environmental risks quantified in The Global Burden of Disease 2010 Study (12), "the greatest contributions to global disease burden were from household air pollution (4.5%, and ranked fourth globally), ambient particulate matter pollution (3.1%; 9th rank), followed by unimproved sanitation, and lead exposure".

Worldwide, outdoor air pollution contributes to approx. 800,000 deaths per year and 4.6 million healthy life-years lost per year. The burden of air pollution is not equally distributed: approximately 65% of the deaths and lost life-years is recorded in the developing countries of Asia (13).

Air pollution levels are tightly linked to climate (temperature, prevailing winds, seasonal changes) and topography (hills and valleys, dominant vegetation, surfaces). Air pollution episodes can be particularly troublesome if the affected city is located in a valley surrounded by mountains (13). This is a case of the Upper Silesian basin, where Ostrava is situated.

The major outdoor air pollutants that are routinely measured (together with lead) are: particulate matter, ozone, nitrogen oxides, carbon monoxide, and sulphur dioxide. Particulate matter is the most frequently used indicator of the air quality. It is a complex mixture of particles that can be solid, liquid or both and varies in size, composition and origin. The summary of the major outdoor pollutants, their sources and health effects are introduced in the Fig. 3.

Environmental Inequity

Subsequently to health inequalities the environmental inequalities are inequitably distributed across population (7). Environmental justice/inequity studies suggest that the level of pollution present in the environment in which vulnerable populations reside is higher than in more affluent areas (14). Subjects in poor areas are more likely to spend time close to or in traffic, working on the street, walking long distances to find transport and commuting in congested, dangerous transport (14). The term environmental injustice describes the disproportionate and inequitable exposure of poor and minority populations to hazards in the environment (15). Less affluent population groups are more often affected by inadequate housing conditions and higher environmental burden in their residential neighbourhoods (16). Housing problems vary from the extreme of homelessness to overcrowding, poor amenities, environmental problems such as noise and pollution, and crime (17).

Environmental injustice is highly correlated with other factors that link poverty with poor health, including inadequate access to medical and preventive care, lack of availability of healthful food, lack of safe play spaces for children, absence of good jobs, crime, and violence (15). The study from Mexico City (14) identified the unfortunate combination of poverty and air pollution causing serious adverse, and often irreversible, health outcomes in children.

The review (16) limited to European evidence identified that the less affluent population groups are most exposed to environmental risks in the place of residence. Inequities were reported for risks experienced within the dwelling (such as exposure to dampness, chemical contamination, noise, temperature problems, and poor sanitation) and related to residential location (neighbourhood quality, traffic-related pollution, proximity to pollution sites). Increased exposure to environmental risks within more affluent population groups was rarely identified. The key finding of the review brought evidence that social status and especially

Pollutant	Sources	Health Effects
Particulate Matter	Automobile, bus and truck exhaust, fuel burning (wood stoves, fireplaces), industry, construction.	↑ infant respiratory mortality ↓ lung function ↓ lung growth ↑ symptoms in asthmatics
Ozone	Produced when nitrogen oxides (vehicle emissions) and volatile organic compounds (VOC) chemically react under sunlight.	↓ lung growth ↑ asthma exacerbations ↑ all respiratory hospitalization ↑ asthma hospitalization ↑ asthma ED visit ↑ school absence for respiratory illness
Nitrogen dioxide	Results from high temperature fuel combustion and atmospheric reactions.	↑ symptoms in asthmatics ↓ lung growth
Carbon monoxide	Formed when carbon-containing fuel is not burned completely, emitted by motor vehicles more than any other source.	↑ asthma hospitalization ↑ clinic visits for lower respiratory tract disease headache
Sulfur dioxide	Industrial sites such as smelters, paper mills, power plants and steel manufacturing plants are the main sources.	↑ asthma hospitalization ↑ clinic visits for lower respiratory tract disease

Fig. 3. *Summary of major outdoor polutants. Reprinted from WHO 2008 (13).*

low income were strongly associated with increased exposure to environmental risks in households or related to residential location (16).

The chronic nature and co-occurrence of exposures to multiple chemical toxicants as well as socially adverse conditions pose methodological challenges for risk assessment (15). Exposures can occur at multiple levels, including the individual and community level. For example, exposure to poverty or substandard housing may be experienced at the individual level (personal income, number of homeless episodes) and the community level (average income in the neighbourhood, amount of concentrated poverty, proportion of imminently dangerous buildings in the neighbourhood). There has been continuing debate whether it is income and market forces or minority status and racism that drive the distribution of environmental pollution among populations (15).

Differential Exposure or Differential Susceptibility to SES – Individual vs. Neighbourhood

Lipfert in his glossary (18) suggests that the inequitable distribution of environmental impacts within a city or region may result from at least two important pathways: differential exposures or differential susceptibilities. Environmental justice refers primarily to exposures. In addition to exacerbating exposures, poverty status may also involve increased susceptibility to environmental challenges by virtue of differences in underlying health status and access to medical care.

WHO in the review on the influence and effects of social inequalities (19) stated that irrespective of exposure, subjects of low socioeconomic status experienced more serious health effects of air pollution. The review confirms that people living in adverse socioeconomic conditions in Europe can suffer twice as much from multiple and cumulative environmental exposures as their wealthier neighbours, or even more. Similarly, inequalities in exposure to environmental threats have been identified for vulnerable groups such as children and elderly people, poorly educated people, unemployed persons, and migrants and ethnic groups (19). The exposure to environmental risk factors is also unequally distributed, and this unequal distribution is often related to social characteristics such as income, social status, employment and education (19).

The effects of both ambient air pollution and socioeconomic position on health are well documented (20). For example, the effect of pollution on child hospitalizations for asthma was confirmed to be greater for children of lower socioeconomic status, indicating that pollution is one potential mechanism by which SES affects health. Several recent studies have addressed the issue whether socioeconomic position modifies the health effects of particulate air pollution and found out that low educational attainment seems to be a particularly consistent indicator of vulnerability in these studies (20). The authors hypothesized that the effects of air pollution exposure on health were differentially distributed by social position and that people in lower social positions were at greater risk. The authors expressed the general hypothesis on three possible routes through which air pollution exposure may resulted in greater health effects among those in disadvantaged circumstances. These routes are as follows: a) air pollution exposure is differentially distributed by social position; b) low social position may directly increase susceptibility to air pollution related health consequences; and c) some health conditions and traits that cause vulnerability to air pollution are linked to social position (20).

The Rome study (21) on relationship between PM_{10} exposure, daily mortality and socioeconomic status brought evidence that due to the social class distribution in the city, exposure to traffic emissions was higher among those with higher area-based income and SES. Meanwhile, people of lower social class had suffered to a larger extent from chronic diseases before death than more affluent residents. The results confirm previous suggestions of a stronger effect of particulate air pollution among people in low social class. Given the uneven geographical distributions of social deprivation and traffic emissions in Rome, the most likely explanation is a differential burden of chronic health conditions conferring a greater susceptibility to less advantaged people (21).

Similarly, other study (22) pointed out that in New York high-SES neighbourhoods were associated with higher concentrations of pollution and stressed the importance of accounting for neighbourhood and individual SES levels in air pollution health effects research (22).

The study on the effect of cross-level interaction between individual and neighbourhood socioeconomic status on adult mortality rates (23) found out that death rates among people of low SES were highest in high SES neighbourhoods and decreased with neighbourhood SES. The differences were not explained by individual level baseline risk factors. The authors concluded that the disparities in mortality by neighbourhood of residence among people of low SES demonstrated that they did not benefit from the higher quality of resources and knowledge generally associated with neighbourhoods that have higher SES (23).

Analysis of cause-specific mortality in 268 sub-national regions (NUTS2) across Europe (24) showed that average PM_{10} concentrations were correlated with low household income but this association primarily reflected East–West inequalities. PM_{10} was more strongly associated with plausibly-related mortality outcomes in Eastern than Western Europe, presumably because of higher ambient concentrations. Populations of lower-income regions appeared more susceptible to the effects of PM_{10}, but only for circulatory disease mortality in Eastern Europe and male respiratory mortality in Western Europe (24).

Health Valuation Related to Air Pollution

There are strong economic arguments for investing in health at population level. In 2001, the WHO Commission on Macroeconomics and Health demonstrated that a healthier population can bring substantial economic benefits to countries by higher productivity, higher labour supply, improved skills as a result of greater education and training, and increased savings available for investment in physical and intellectual capital (4).

Clear understanding of the cost of ill health is a prerequisite for assessing the economic returns of investing in health. While healthcare costs are substantial and increasing, these represent only one part and the very limited perspective considering micro- and macroeconomic costs and the broad perspective encompasses social welfare costs. Cost of illness studies separate costs into three components: direct costs (associated with treating illness), indirect costs (associated with loss of productivity due to morbidity or premature death) and; intangible costs which include the psychological dimensions of illness (only rarely measured). A review of cost of illness studies found that the cost of chronic diseases ranged from 0.02% to 6.77% of a country's GDP. Cardiovascular disease in particular was found to account for between 1–3% of GDP in most developed countries (4).

Social or socioeconomic value of externalities such as quality of life, noise, environmental pollution etc. is perceived as "market unpriced goods" and it should be counted as an indirect cost. Social meaningfulness or social efficiency is derived from the results of cost-benefit analysis. The benefits are understood as saving lives, reducing negative impact on the environment etc. The main concepts are based on willingness to pay (WTP) for specific goods (monetary value); on willingness to accept (WTA) negative effects related to the goods clearly defined by monetary value; and on opportunity costs that are used to determine the shadow prices of goods related to human activity (25).

The social value of externalities is usually determined using a questionnaire survey and hedonic regression, where the price of externality is derived from the model with the externality as the explanatory variable. The value of human life is estimated using several models: method of human capital – based either on the sum of discounted future potential earnings, or the sum of discounted net expenditure; value of a statistical life (VSL) – based on WTP to reduce the risk of death; and value of life year (VOLY). VSL and VOLY estimate the value of life on the basis of expressed preferences (25), e.g. a limit value that the individual is willing to exchange for safety (26). The human capital approach has 300-year tradition, but is criticized as methodologically wrong (26).

When looking at health using a concept of health as both consumption and capital goods, health as consumption goods directly contributes to an individual's happiness or satisfaction, and as capital goods, health is an important component of the value of human beings as means of production (6). Inequalities-related losses to population health were determined by calculating the frequency of ill-health in the population not achieving adequate level of education, occupational class or income level. While the estimates of inequalities-related losses to health as a capital good seem to be modest in relative terms (1.4% of GDP), they are large in absolute terms (€141 billion). Inequalities-related losses to health account for 15% of the costs of social security systems, and for 20% of the costs of healthcare systems in the European Union (6).

A key element for the calculation of the damage costs of air pollution, namely the valuation of mortality provides the paper from 2011 (27). The authors explain that quantification of the costs of air pollution mortality by value of prevented fatality (VSL) is not correct and prefer the method of contingent valuation. Based on the results of contingent valuation survey that was conducted in 9 European countries the authors recommend VOLY estimate of 40,000 € (confidence intervals at least 25,000 € and at the most 100,000 €) for cost-benefit analysis of air pollution policies for the European Union.

The VOLY is also recommended as the most relevant metric for valuation of the health impacts of ozone and particulate matter for the cost-benefit analysis being undertaken as part of the Clean Air For Europe (CAFE) programme (28). Empirical studies provide direct estimates of VOLY, and there has been recent work deriving VOLY values (computationally) from VSL in the air pollution context. Consequently, mortality effects of long-term exposure to PM will be expressed both as years of life lost and as attributable cases of premature mortality, and both are relevant for monetary valuation (28).

Studies on Environmental and Health Inequalities in Industrial Ostrava Region

In Ostrava agglomeration lives 80% of total population of the Moravian-Silesian region. At present, aging of population, high unemployment, poor educational structure and crime, especially in the peripheral parts of the region, are the main problems, and the situation threatens to get worse (29). The document Development Strategy of the Moravian-Silesian Region (30) introduces the situation in Ostrava as a typical example of accumulation of structural backwardness and load generating stress of population that combines air pollution and its health impacts, tense situation in employment, safety problems, criminality, and concentration of numerous excluded Roma localities.

Air pollution could be one of the key factors for the dispersion of population growth and suburbanization (31). However, air pollution influences the suburbanization process only partly. Based on sociological research from 2010 only 10% of households in Ostrava want to move from the city in the future and the environment is even the third of the stated reasons (after housing and work). A significant migration flow from Ostrava is directed into new houses in the eastern edge of the city with significantly worse state of the environment, but considerably cheaper land. Wealthier population prefers the western edge of the city with a better quality of environment. Similar trends can be seen also in other major cities in Europe (31).

According to the periodic survey on health and lifestyle in middle age population in 19 Czech cities (HELEN 2010), in the Ostrava region, worse socioeconomic status indicators were found comparing with other cities in the study. The highest prevalence of risk life-style factors (obesity, lack of physical activity, smoking, excessive alcohol consumption, or unhealthy diet) was indicated in Ostrava (32).

Unemployment represented 2.9% of total burden of disease caused by specific risk factors/conditions in the EU in the year 1997 (33). Socioeconomic atlas of Ostrava (34) brought information on geographical distribution of unemployed people with low education. This group of citizens together with young people shortly after school and people close to retirement who lost their jobs are among the most vulnerable in the labour market. The average proportion of low educated inhabitants in Ostrava represents 36% of the city population, but in some parts of the city this proportion reached 72% (34). The monitoring of socially excluded localities of Ostrava (35) stated that the high level of unemployed with basic education (usually more 60%) seems to be a typical symptom of gypsy communities, additionally with a high share of young people. In Ostrava, 18,000 of inhabitants (i.e. 5.4% of total population) received social benefits in 2010. The welfare recipients are concentrated predominantly in the central and eastern parts of the city. Also crime, mostly thefts, is concentrated in the central city quarters with a higher crime rate in the socially problematic locations. The lowest criminality was found in the western parts of the city (34).

In spite of the state assistance in material poverty there are some proportion of homeless population. According to the study of the state of homelessness in Ostrava (36) the total number of homeless (living outside shelters or in asylum houses) reached 890 in 2012. The authors of the study introduced hidden and potential homelessness. Hidden homeless (1,797 persons) are those without own housing living in public hostels. The largest group created potential homeless (18,833 persons) – people living in socially excluded areas and individuals without a permanent address, released from prison or young people leaving foster care. The highest concentration of homeless is in the central and western parts of the city.

The results of sociological studies point out that the effects of air pollution on health should be assessed differently depending on the social composition of the area population. The White Paper on allergy from 2011–2012 states that morbidity and mortality from asthma is more concentrated in the lower social class due to higher exposure to ambient and indoor air pollution including tobacco smoking. In spite of the differences in findings of health studies focussed on children respiratory morbidity in Ostrava (32, 37), some SES consequences were detected: a lower socioeconomic status was associated with worse control of asthma (especially in the eastern heavy polluted part of Ostrava, where also the highest prevalence of asthma was found), a higher proportion of mothers with lower education, higher prevalence of smoking mothers before conception and during pregnancy, and also higher proportion of current smoking households (32).

The article published in 2008 (38) summarizes results of studies of relationship between air pollution and population health in the Ostrava-Karvina region carried out in the period from 1994–2006 by the researchers of the Institute of Public Health in Ostrava. The results did not confirm a transparent relationship between air pollution and prevalence of allergy. However, increased concentrations of PM_{10} and NO_2 have been listed among other risk factors of higher frequency of cough and inhalation allergy. Lung function of children was also significantly affected by mother smoking in pregnancy and by smoking in household during their life-course (38).

CONCLUSION

The theoretical background and also results of the studies brought evidence on determinants of health status of population not only by environmental but also social factors. Individual lives and also population health are affected by both socioeconomic and environmental inequalities. Air pollution is unevenly distributed in Ostrava and is related with distribution of socially disadvantaged environment and social exclusion. The health studies indicated that there existed unexplained factors behind identified direct relationships between health and known risk factors and determinants and probably related to lifestyle factors and socioeconomic inequalities. In spite of that the primary goal of the paper was not to assess financial costs of ill health, it provides in addition a guide for estimation of the financial losses due to environmental inequity.

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