

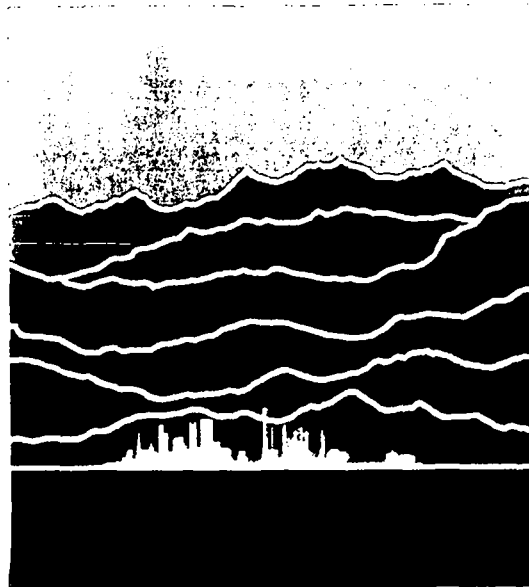
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NATIONAL INTEGRATED PROGRAMMES ON ENVIRONMENT AND HEALTH IN CENTRAL- AND EASTERN EUROPE

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HUMAN HEALTH AND THE PHYSICAL ENVIRONMENT IN CENTRAL- AND EASTERN EUROPE



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Human Health and the Physical Environment in Eastern Europe

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Executive Summary

This paper has four sections. The first section describes the life expectancy gap which has emerged between the West (herein, Western and Northern Europe, North America, and Japan) and Central and Eastern Europe (herein, Bulgaria, Czechoslovakia, Hungary, and Poland) over the past three decades, with the intention of placing the environmental health problems of the East in a useful context. The second section provides a summary of these problems based on ad hoc disease groupings. The third section profiles two regional "hot spot" areas, showing the way in which multiple environmental health problems co-exist in areas of particularly severe environmental degradation. This is followed by details of local hot spots. The final section presents country-by-country recommendations for further public health activities in relation to the environment, based on the recommendations I made to the World Bank after each of my investigating visits to the four countries in question.

The data available to evaluate environment-health relationships in Eastern Europe is generally of poor quality, making it difficult to be unequivocal about what we believe to be true about environment-health relationships there. This is specially true when it comes to evaluating the impact of the environment on chronic diseases of adulthood, which, unlike lead poisoning, may have multiple causes related to lifestyle and the social environment. Nonetheless, six groups of human health problems have valid links to exposures in the physical environment of Central and Eastern Europe. These include overexposures to lead; threats to normal childhood development; respiratory disease in childhood and adulthood; threats of mortality, both in infancy and from the chronic diseases of adulthood; disease due to exposures to nitrates and arsenic in water; and miscellaneous concerns specific to local areas.

Two regions, namely, the mining districts of North Bohemia and Katowice province of Silesia, may be thought of as regional hot spots, because widespread environmental pollution from multiple local and transboundary sources seem to affect all members of the population in these large geographic areas. In addition, there are a large number of local hot spots throughout the four countries in question, wherein the health of selected populations are affected by emissions from one or more point source of pollution.

The countries dealt with here need similar sorts of technical assistance to strengthen the public health effort against environmental pollution. Routinely collected health data and disease registries need to be upgraded to serve as valid sources of information on health status and of outcome data for special studies. The quality of chronic disease epidemiology needs to be improved so that population studies become valid and reliable enough for policy making. Quality control programs need to be instituted for environmental and biological data and multi-disciplinary teamwork and inter-ministerial co-operation need to be fostered. Finally, several hot spot areas require extensive further investigation so that the allocation of scarce resources for clean up can be made with full knowledge of human health impacts in the most polluted places.

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1. The Life Expectancy Gap in Eastern Europe

In retrospect, it is clear that the evolution of life expectancy in the countries of Central and Eastern Europe has passed through two distinct phases since World War II. First came a phase of rapid convergence with Northern and Western Europe and North America (herein called the West), which historically had had higher life expectancy. This phase began in the late 1940s throughout Central and Eastern Europe, in the aftermath of World War II, and continued until the mid 1960s. (Its end date, however, is somewhat indistinct, varying from the early 1960s in Czechoslovakia to the early 1970s in Bulgaria). This convergence was the result of rapid increases in life expectancy in the East concurrent with slower increases in the West (Figures 1a and 1b). The second phase, which has lasted from the end of the first phase to the present, has witnessed a re-emergence of the East-West life expectancy gap. During this phase life expectancy in the West has continued to rise while rising hardly at all, or even declining, in the East (Figures 1a and 1b).

Age-specific mortality rates and supplementary life expectancies from middle age onward could be said to "explain" the two phases described above. In the late 1940s and early 1950s, infant mortality rates in the East were markedly higher than in the West. For instance, Czechoslovakian infant mortality rates, the lowest in the East, were 61.6 and 48.9 per 1000 live births for males and females, respectively, in 1952, while the Swedish infant mortality rates were 24.3 and 18.5, respectively, in 1950. By 1960, however, these differences had been dramatically reduced. The gap of 37.3 deaths per 1000 live births in male infant mortality had closed to less than 8.7 (an IMR of 26.9 for Czechoslovakian males in 1960 and 18.2 for Swedish males in 1961). For females the IMR gap had fallen from 30.4 in the early 1950s to 6.9, based on an IMR of 20.9 for Czechoslovakian females in 1960 and 14.0 for Swedish females in 1961. Figures 2a and 2b show that this pattern holds generally for East-West comparisons.

A comparison of the evolution of supplementary life expectancy after age 30 in the East and West in the post-war period shows something very different from the infant mortality comparison. There has not been a period of convergence between East and West. For males in the East there have been no sustained increases in supplementary life expectancy, and even modest decreases, during a time in which it has increased slowly, then more rapidly, among men in the West. Females in the East have made gains in supplementary life expectancy after age 30 in the post-war period, but not as large as their counterparts in the West. For instance in Czechoslovakia in 1949-50, female supplementary life expectancy after age 30 was 43.0 years and rose to 46.2 by 1985. In Sweden it was 44.6 years in 1946-50 and 51.1 years in 1987. This difference of 6.5 years was greater than the difference in life expectancy at birth of approximately five years in the late 1980s (75.4 in Czechoslovakia in 1989 and 80.4 in Sweden in 1987). Once again, the comparison between Sweden and Czechoslovakia seems to accurately reflect the evolution of East-West differences in life expectancy, which are basically the same for females as they are for males (Figure 3a and 3b).

In summary, the evolution of life expectancy in the East has undergone two phases. During the first, lasting until the mid-1960s, rapidly declining infant mortality rates led to a near convergence of East-West life expectancy. During the second phase, lasting from the end of the first to the present, East-West differentials in survival re-emerged, based primarily upon differential survival starting in middle age.

Figure 1(a): Temporal Trends in Life Expectancy - Males

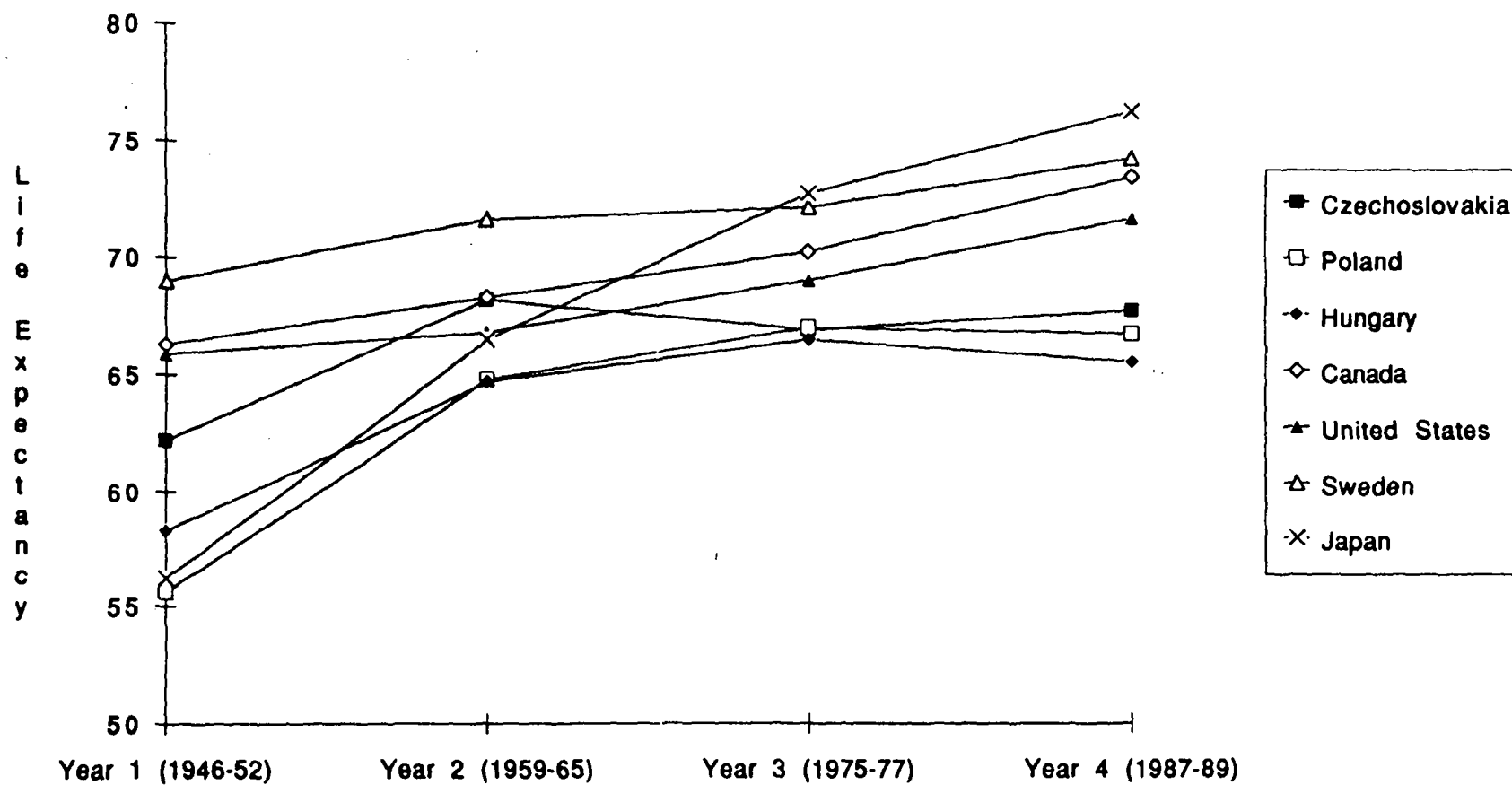


Figure 1(b): Temporal Trends in Life Expectancy - Females



Figure 2(a): Temporal Trends in Infant Mortality - Males

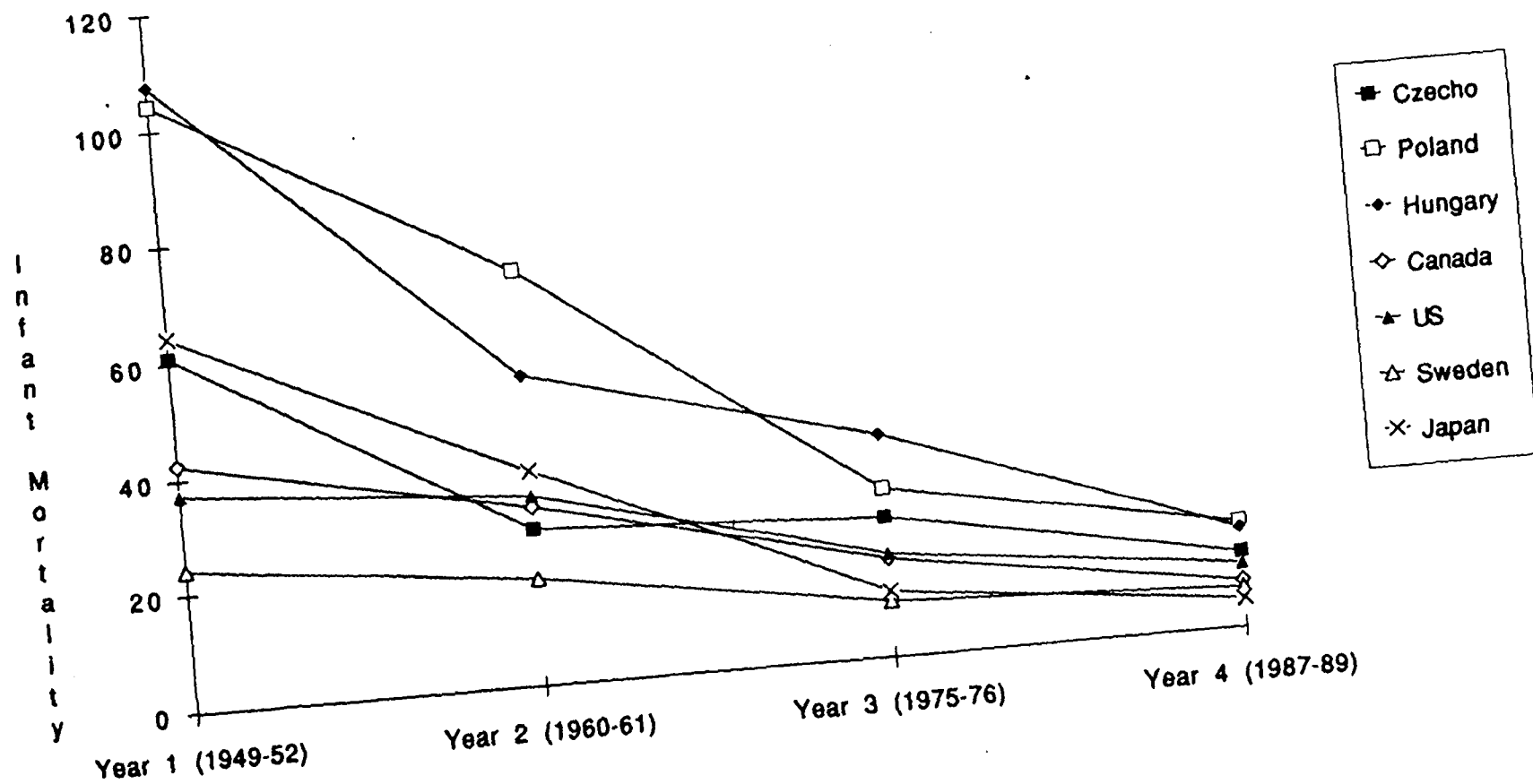


Figure 2(b): Temporal Trends in Infant Mortality - Females

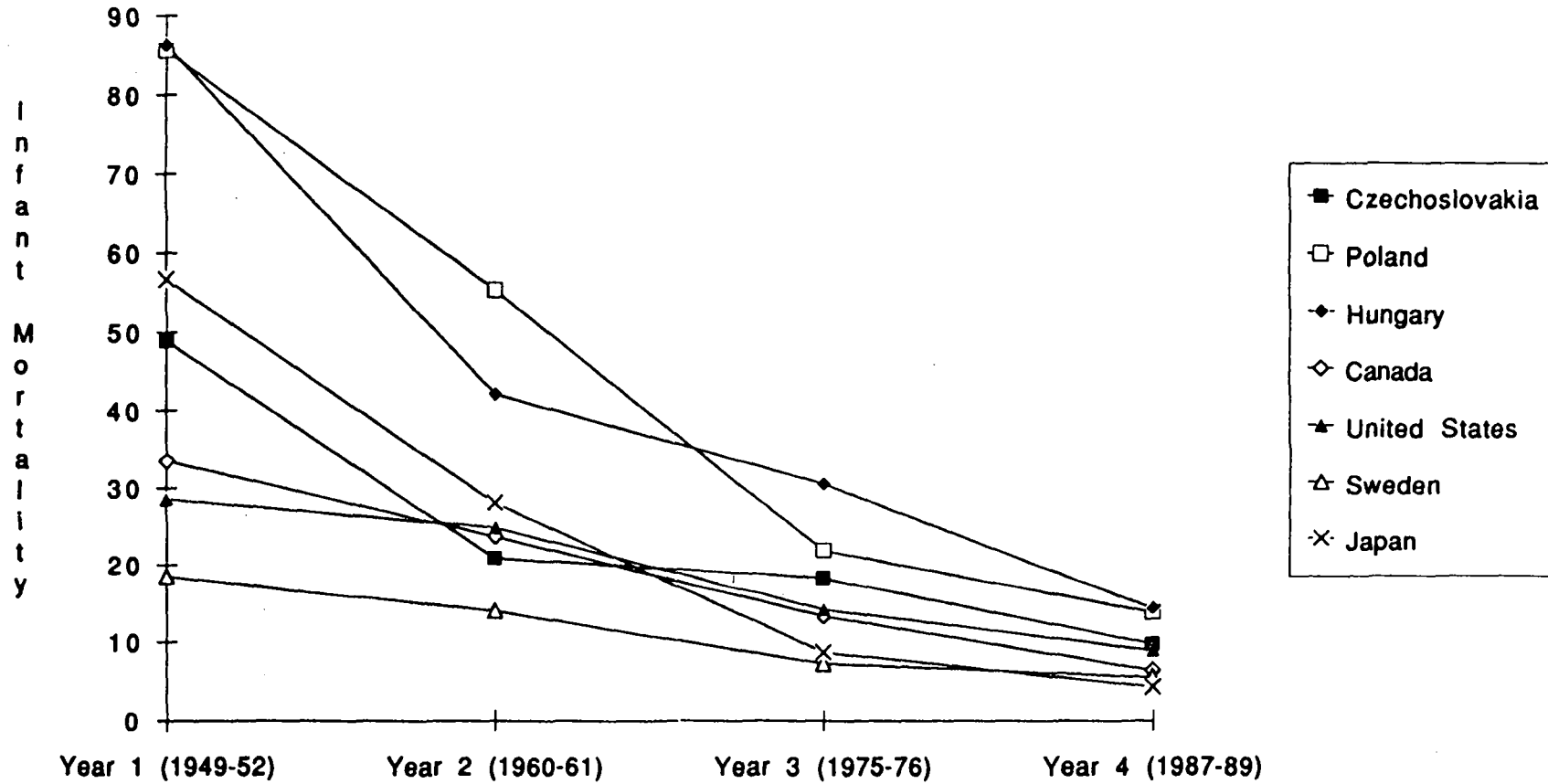


Figure 3(a): Temporal Trends in Supplementary Life Expectancy After Age 30 - Males

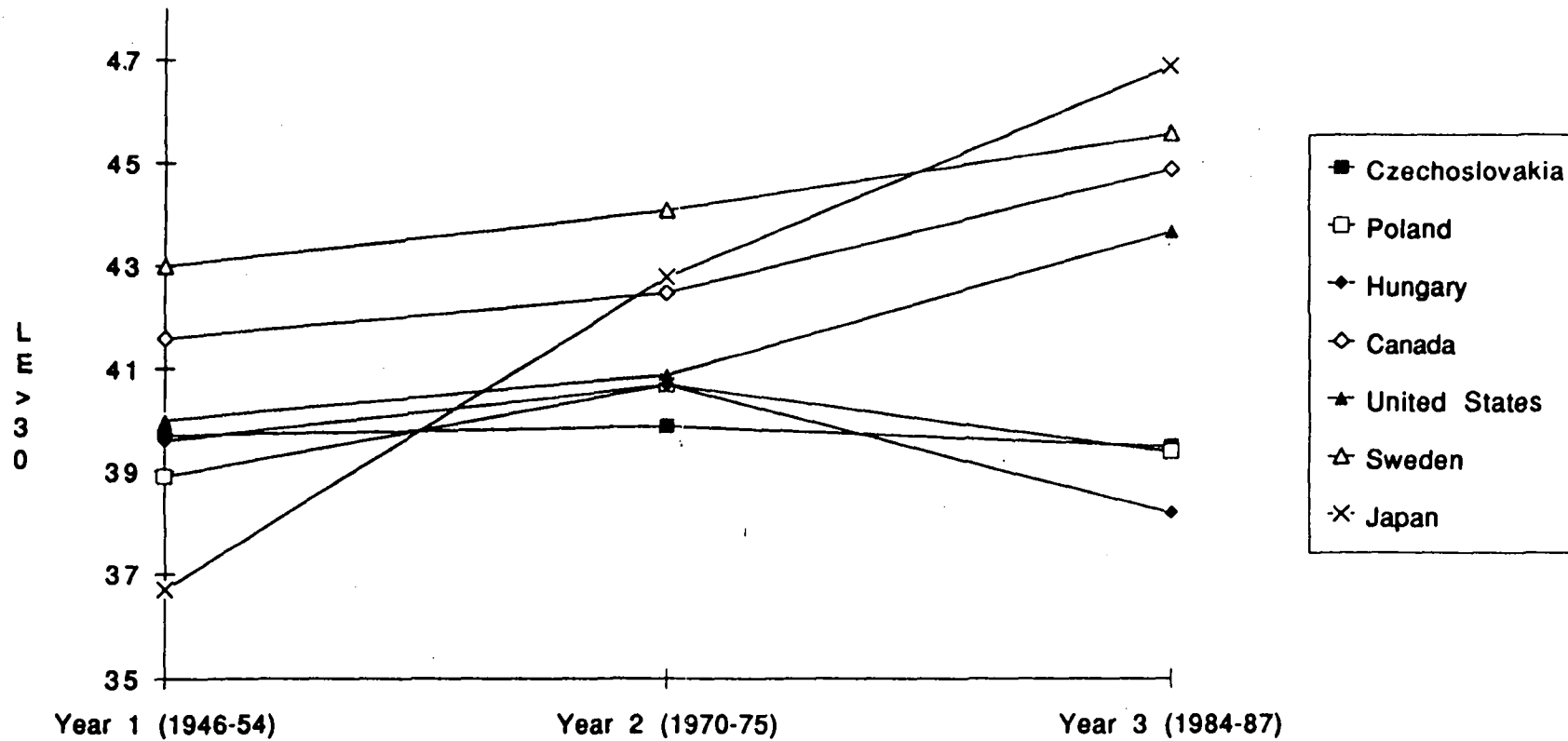
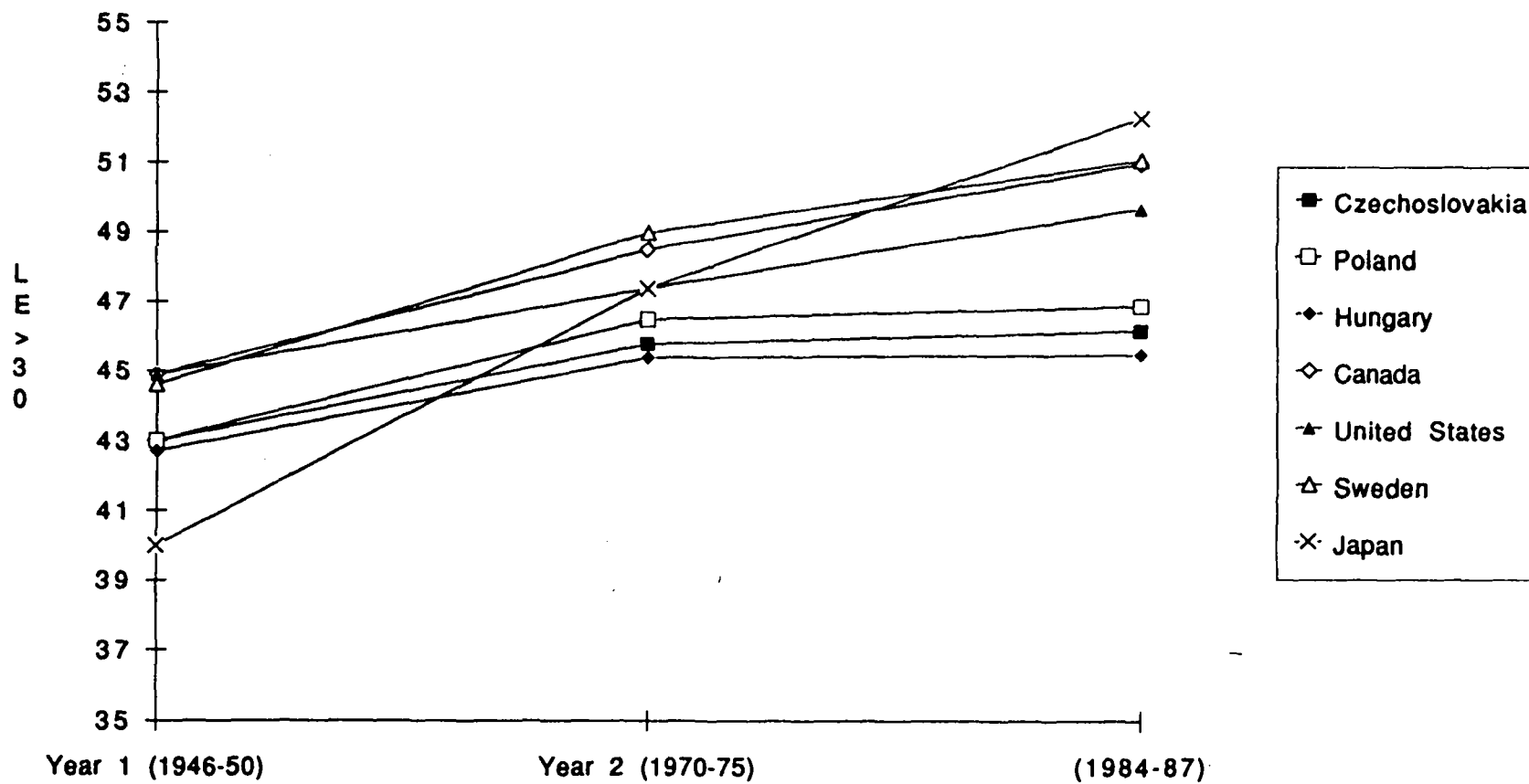


Figure 3(b): Temporal Trends in Supplementary Life Expectancy After Age 30



Competing Explanations for the Current Life Expectancy Gap

Public health officials and researchers interested in East-West comparisons have informally identified five competing approaches to explain the life expectancy gap. These are presented here to set the context for the discussion of human health impacts of environmental pollution.

1. "Historical Inevitability"-- This approach begins with life expectancy data from "Mitteleuropa" reaching back into the 19th Century, which point out that East-West differences in life expectancy have been the norm over the past hundred years. In this context the phase of convergence in life expectancy after World War II looks like an anomaly which can be explained, by being explained away. This is done by asserting that patterns of life expectancy in the East simply lag behind the West by a generation or so. In the post-war period of convergence in life expectancy the East experienced a decline in infant mortality like the one that had occurred earlier in the West, but it did so at a time when the West was experiencing an increase in mortality from chronic disease, and, therefore, limited gains in life expectancy. Thus, the period of convergence was an historical artefact, and normalcy was restored when the West entered a period of postponement of mortality from chronic disease and the East, *inevitably*, started to experience increased mortality from chronic diseases. In the extreme, this approach leads to two conclusions, namely, that chronic disease mortality will inevitably begin to decline in the East, and, presumably, that no special measures need to be taken to assist the process.

2. The "physical environment"-- This approach begins with the assertion that the gap in East-West life expectancy re-emerged around the time that environmentalism and a concern with worker health and safety got onto the public policy agenda in the West. Although the East Bloc countries had laws on the books to match those in the West, these were ignored, and, as a result, the public has been exposed to increasingly polluted air, water, soil, and food. These exposures are not only the proximate causes of specific morbidity, such as asthma and chronic lead poisoning, but are also responsible, to some degree, for mortality from respiratory diseases, certain cancers, congenital anomalies, and perhaps cardiovascular diseases. Moreover, living in a polluted environment is very damaging to the population's sense of well-being, instilling in people a sense of imminent threat. Under such conditions people will not be responsive to messages that tell them to modify personal habits that threaten their health over the long term, since the relevant threat is seen to be in the present, not the future.

3. "Health care and the economy"-- According to this approach, "real socialism" was well suited to provide public health services to the masses, but it was unable to adapt to high-tech modern medicine. Just as the economies of the East seemed unable to make the transition from an industrial to a service-information base, they could not meet the need for increased local autonomy, professional independence, and strategic capital formation that some observers believe is fundamental to a successful health care system. Furthermore, these problems were exacerbated by a shortage of hard currency in the East, increasingly needed to purchase Western equipment that was not available from CMEA producers. Thus, despite its large supply of health professionals the East was increasingly unable to match Western standards of diagnosis and treatment of the chronic diseases that are the principal causes of mortality. The validity of this approach depends, in principle, upon whether or not the life expectancy gap can be explained by East-West differences in case-fatality rates for medically-avoidable causes of death.

4. The "risk factor" approach-- This approach begins with the observation that, for both sexes, most of the age standardized mortality differential between East and West can be attributed to a single cause: higher circulatory disease mortality rates in the East, which

emerged concurrently with the life expectancy gap. Therefore, East-West differences in smoking habits, blood pressure control, and diet/obesity/cholesterol, the epidemiologically validated risk factors for heart disease and stroke, can explain the life expectancy difference. The public policy corollary of this approach is that well designed health promotion programs should be able to successfully eliminate the life expectancy gap without major recourse to other measures.

5. The "socioeconomic analogy"-- This can be summarized simply by asserting that the political, social, and economic conditions in the East created a climate of powerlessness and alienation which simulated, in varying degrees, the conditions of relative deprivation experienced by people of low socioeconomic status in the West. Improvements in socioeconomic conditions will be the most effective means of reducing the life expectancy gap. Furthermore, health problems associated with poor lifestyle choices will be refractory to direct intervention among the majority of the population until the socioeconomic environment improves.

It is not the purpose of this review to evaluate the relative importance of each of these competing explanations. This has, in any case, been done at length elsewhere. The purpose of providing a description of their relative importance here is to help put the impact of the physical environment on human health in perspective. The results of this evaluation can be summarized as follows:

*The historical inevitability explanation is largely refuted by the example of Japan, where dramatic declines in infant mortality in the post-war world were accompanied by concurrent increases in supplementary life expectancy from middle age onwards.

*The limited role played by health care can be shown by evaluating the historical evolution of East-West differentials in standardized mortality rates for medically-avoidable causes of death. Using this methodology, less than ten percent of the life expectancy gap can be attributed to poorer quality health care services in the East than the West.

*The risk factor approach currently has the most credibility among epidemiologists and public health officials interested in East-West comparisons. This is based primarily on evidence that smoking and dietary animal fat are more prevalent in Eastern Europe than in the West. However, this belief has yet to overcome three important challenges.

1. There is no evidence of higher smoking rates among Eastern Europeans in the age cohorts at risk of heart disease in the late 1960s and 1970s, when the life expectancy gap first emerged.

2. Data from the MONICA project reveal some important weaknesses in the relationship between obesity, cholesterol, and heart disease. For instance, cardiovascular mortality for males aged 35-64 in Budapest ranked *third* among the participating centers, and it ranked *second* for females in the same age range. However, for males the proportion of serum cholesterols above 250 mg/dl ranked *twenty-sixth* among participating centers. The proportion of elevated blood pressures ranked *thirtieth* for diastolic and *twenty-third* for systolic measurements and the proportion of grossly elevated body mass indexes ranked *twenty-second* overall. For females, the proportion of serum cholesterols above 250 mg/dl and the proportions of elevated diastolic and systolic blood pressures all ranked *twenty-fourth* among participating centers, while the proportion of grossly elevated body mass indexes ranked *twenty-sixth*.

3. Despite the fact that certain patterns of cholesterol, triglycerides, and lipoproteins are strongly predictive of cardiovascular disease in Western societies (where average societal levels are already high), intervention studies of diet and medication designed to change these patterns have not demonstrated any reduction in overall mortality. Thus, we have little scientific reason to believe that the life expectancy gap can be significantly altered through dietary change.

*The socioeconomic analogy has promise because it deals directly with issues such as peoples' perceptions of control in their lives and their level of social support; factors which should show crucial differences between authoritarian and democratic societies. However, we currently have little useful international comparison data to evaluate this explanatory approach.

2. Health and the Physical Environment in Eastern Europe

There are six types of human health problems which have been "linked to" agents in the physical environment of Central and Eastern Europe. These are:

1. Overexposures to lead.
2. Threats to normal childhood development.
3. Respiratory disease in childhood and adulthood.
4. Threats of mortality, both in infancy and from the chronic diseases of adulthood.
5. Exposures to nitrates and arsenic in water.
6. Concerns specific to local areas.

An outline of the available information related to these problems will be presented later in this section. Prior to that, five strategic issues are identified which transcend each group of health problems, and which should be of special interest to international agencies planning environmental health assistance for Eastern Europe.

1. One of the principal impediments to understanding environment-health relationships in Eastern Europe is the generally poor quality of data regarding exposures to environmental agents and, also, the assessment of human health outcomes. In the exposure measurement field there has been little attempt to develop and maintain quality control programs. As a result, embarrassing inconsistencies are often found when more than one agency has collected exposure data at the same place and time. These inconsistencies are usually identified by outsiders and not by the agencies concerned. Also, the assessment of human health outcomes has taken place without due regard for epidemiologic principals which help ensure the validity of results. In particular, few of the health studies from the region allow us to simultaneously assess the impact of environment, lifestyle, and social factors on disease causation. These methodologic problems make it difficult to be unequivocal about what we believe to be true about environmental health in Eastern Europe.

2. Is there a useful distinction to be made between local environmental health problems caused by point sources of exposure and regional problems such as those symbolised by the "black triangle" of North Bohemia, Silesia, and Southern "East" Germany? In other words, might our concern with large-scale, well-publicised areas of environmental disaster distract our attention from local areas with less well characterised problems which, nonetheless, might turn out to be of greater human health significance? This is of special importance because the quantity of data currently available to evaluate each environmental health concern is not proportional to the potential human health impact of that concern.

3. Is it possible to say whether particulates are or are not a more important source of air pollution than sulfur dioxide, from the standpoint of human health? Much has already been made of this distinction because it is easier and cheaper to control particulates than sulfur dioxide.

4. In Eastern Europe, like in many other places, agencies of the Ministries of Environment are staffed with personnel whose training and orientation is much different from their counterparts in the Institutes of Hygiene and other agencies of the Ministries of Health which deal with the public health consequences of environmental pollution. There is no question that the initiatives taken by international agencies will influence which of these agencies will be mobilized and which will be isolated in efforts to improve the environment. For instance, epidemiologic approaches will tend to mobilize health agencies while quantitative risk assessment activities will tend to mobilize environment agencies. Is it possible to formulate initiatives which encourage intersectoral collaboration and reward technical expertise, rather than exacerbate fragmentation of effort and unproductive competition between agencies?

5. A crucial issue, related to the earlier discussion about the East-West life expectancy gap, is the extent to which living in a heavily polluted environment can influence health status through interaction with other determinants of health. In particular, to what extent does living in a polluted environment exacerbate feelings of futility about the value of making lifestyle changes to improve personal health? To what extent do the problems associated with a polluted physical environment create or exacerbate negative conditions in the social environment.

Over-exposures to Lead

Hot spots for lead exposure exist in each of the four countries in question here. They tend to occur nearby industrial point sources (especially smelters) where there are elevated levels of lead in the air, soil, and local produce, and, also, in urban areas near heavy traffic flows. Lead concentrations in air and soil tend to be higher in Eastern European hot spots than in the West. Here are some examples of 6-12 month average airborne lead levels compared to Canada and the city of Vancouver:

Inner Budapest	(1980s)	2.9-5.3 ug/m ³
Katowice	(1987)	0.5-2.6 ug/m ³
Ruse, Bulgaria	(1979-89)	1.8 ug/m ³
Prague 1	(1989)	0.8-1.6 ug/m ³
Cdn Hot Spots	(1985-89)	0.4-1.0 ug/m ³
Vancouver	(1989)	0.1-0.2 ug/m ³

Similarly, soil lead concentrations in hot spot areas may be well above acceptable levels for residential dwellings. In one hot spot in Katowice, soil lead levels exceed 19,000 parts per million and near Pribram, Czechoslovakia they exceed 5000 ppm.

In studies in the West, it has been consistently shown that soil and housedust are the principal sources of lead exposure to children, especially among those young enough to be playing on the ground, mouthing their toys, and licking their dirty hands. In the rural hot spots of Eastern Europe, these sources of exposure may be augmented by high levels of lead in food. For instance, in the smelter town of Pribram in the Czech Republic, it was estimated that exclusive use of home grown fruits and vegetables would provide 1042% of the acceptable weekly intake of lead for children. A similar problem likely exists in the Plovdiv-Kuklen-Asenovgrad area of Bulgaria where lead smelting is taking place in the middle of some of the richest farmland in the country. Studies among adolescents in certain parts of Silesia have shown dietary lead intakes as much as seven times above acceptable weekly intakes for those in the highest decile of intake.

Average blood lead levels among children in Eastern European hot spots are usually greater than 15 ug/dl and sometimes exceed 40 ug/dl. Levels like this were not uncommon in the West until twenty years ago, but are very high by today's standards. For instance, the highest average blood lead level in a local community in Canada in recent years, measured in a smelter town with particularly unfavourable meteorologic conditions, was 13.8 ug/dl among a complete census of the town's 3-6 year olds. In Vancouver, a city of 1.5 million with no leaded gasoline for sale and virtually no other point sources of lead, the average blood lead level among 2-3 year olds was 5.3 ug/dl.

The main concern with chronically elevated blood lead levels is their potential neurobehavioural effects on children. The most recent research on this topic suggests that these may be non-threshold effects, detectable at blood lead levels below 10 ug/dl, and may have a significant effect on children's educational attainment. Complete neurobehavioural studies have not been completed in many hot spots in Eastern Europe, although some effects have been reported in Pribram, Plovdiv, and Romhany (Hungary). The most clear-cut evidence of lead toxicity comes from a study of 231 children in Katowice, Poland, where a 13 point IQ gradient was found between those with the highest and lowest blood lead levels. Among these children two-thirds were anemic; one-third had chronic digestive tract symptoms; 77.5% had electroencephalogram changes; three had peripheral nervous system pathology; and virtually all had chromosome abnormalities in samples of white blood cells.

No country in Eastern Europe has done a comprehensive survey of its potential lead hot spots or conducted the sort of multisource exposure study useful for developing a cleanup strategy. The most complete information I found was in Bulgaria, where data was available on several hot spot areas, often including adult blood lead levels as well as children.

Threats to Normal Childhood Development

This group of problems includes a variety of conditions that are not necessarily symptomatic but will likely affect health and well-being later in life. Documented examples exist in Czechoslovakia, Bulgaria, and Hungary. Studies of children removed from polluted environments in North and Central Bohemia during the winter have shown improvements in their pulmonary and immunologic function, as well as hemoglobin status, when they are away, which reverse when they return to their home environment. There is also evidence from the mid 1970s and 1980s that delayed bone maturation was a problem in more than 30% of sampled children in North Bohemia.

Ruse, Bulgaria, has had recurrent problems with elevated levels of airborne dust, oxides of nitrogen, hydrogen sulfide, lead, and hydrochloric acid. A developmental study done there suggested that approximately 50% of the town's children were below their expected developmental level for weight, height, and chest expansion. In Dimitrovgrad, which experiences high levels of airborne dust, sulfur dioxide, hydrogen sulfide, lead, and hydrogen fluoride, a more complete study was done on respiratory development among a sample of children. This study employed spirometry, which, when conducted properly, gives very reliable information about lung capacity. The study showed that, at age 11, the "FEV₁", or volume of air which could be exhaled in one second, was an average of 300 millilitres lower in Dimitrovgrad than in a control town. This difference increased with age, such that the difference for 14 year olds was approximately 800 millilitres. This is a strikingly large difference.

In Dimitrovgrad another sample of 100 children, aged 7-14, were clinically evaluated and classified according to developmental status. Only 18% were said to be developing normally, compared with 72% of the control children. 37% were said to have slight developmental problems, and 45% were classified as being in a state of "chronic, compensated disease". An example of this latter might be a child who had evidence of obstructive airways disease on spirometry, but was able to play and exercise normally by relying upon respiratory reserve. In the smelting town of Ajka in Hungary, studies of pulmonary function revealed that airways obstruction was 2.8 times more frequent in girls and 3.6 times more frequent in boys than in a control community.

Although there are fewer studies of developmental status among children than there are of specific diseases, these studies are very important for estimating the burden of morbidity that children can expect to take into adulthood. Like lead over-exposure, we do not have a comprehensive and systematic picture of the developmental status of children in all the polluted regions of Eastern Europe. Therefore the examples which are particularly striking are not necessarily the only ones of importance.

Respiratory Disease

Respiratory disease in relation to air pollution is the most commonly reported environmental health problem in Eastern Europe. This is not surprising because high levels of exposure to sulfur dioxide and particulates are widespread throughout the region. The following data show the range of average annual ambient sulfur dioxide levels in regions of each country, using Canada as a comparison.

Czech Republic (1981-1988)	0.4-184.1 ug/m ³
Hungary (heating season 1987-88)	36-112
Poland (1988)	3-636
Bulgarian Hot Spots (1989-90)	28-485
Canada (1985)	0.2-45

Similarly, these data show, in a much more abbreviated form, the range of average annual ambient suspended dust levels.

Czech Republic (1981-1988)	18.3-222.8 ug/m ³
Silesia (1987)	174-318
Canada (1985)	17-100

Data on short-term exposures show larger differences, for instance in North Bohemia sulfur dioxide concentrations frequently exceed 1000 ug/m³ during winter inversions.

Here are some of the findings of studies of respiratory disease in relation to air pollution in the region.

*In Poland, chronic bronchitis and asthma rates among army recruits at age 19 strongly correlated with sulfur dioxide levels measured at the monitoring stations nearest their homes.

*A 13-year follow-up of respiratory health in Krakow seemed to suggest that occupational exposures were more important than environmental exposures in explaining the development of chronic bronchitis.

*Acute bronchitis, asthma, and/or various acute upper respiratory syndromes among children were found to be elevated in the hot spot areas of Ajka, Dorog, and District 22 of Budapest, Hungary.

*In North Bohemia, "nonspecific lung/airways diseases" were found to be 3-5 times more prevalent on compulsory school medical exams than in Czechoslovakia as a whole.

*Correlations between the incidence of acute respiratory disease and air pollution were found in certain places in Central Bohemia and in Bratislava.

*In Bulgaria, respiratory disease has been studied in relation to air pollution in at least nine local areas. Some studies are time series correlations of air pollution and respiratory disease, others are controlled studies; some use routinely reported health data, others use special medical exams; some use incidence data, others use prevalence data. All are "positive" in the sense that at least one disease process was elevated in each hot spot.

The respiratory disease studies, taken together, are quite consistent with one another in showing acute effects, and, together with the studies of pulmonary function in children, imply chronic effects as well. However, as a group these studies are not well designed and, so, many of them are not very convincing when looked at individually. Does the fact of consistency across a series of studies count for more than the individual validity of each one? In this case I believe it does. In other words, the general conclusion that respiratory health has been affected by air pollution is a valid one, even though certain local claims may be questionable.

Mortality

The influence of the physical environment on mortality is not easy to evaluate and still harder to summarize succinctly. Unlike lead poisoning, none of the major causes of mortality is uniquely attributable to factors in the physical environment. Therefore, studies linking mortality by specific cause to variations in pollution levels are unsatisfactory for making causal inferences unless they take into consideration various lifestyle and social factors. The subject is of vital importance because over the past 20-30 years, life expectancy in Eastern Europe has fallen behind the West, primarily on the basis of the failure of the region to make any gains in supplementary life expectancy from middle age onwards. When broken down by specific cause of death, cardiovascular diseases turn out to be the principal source of the East-West mortality differential. Virtually no work has been done anywhere to properly evaluate the impact of the non-occupational environment on cardiovascular disease. Presumably, Eastern Europe represents a unique opportunity to do so, but for now we are left with information on infant mortality and adult mortality from a few other causes.

Evidence of an impact on infant mortality comes from Poland, Bulgaria, and Czechoslovakia, but not from Hungary. Infant mortality rates by subregion within Katowice (the most polluted part of Silesia) correlated with ambient levels of several pollutants in those subregions for a sample of six years in the 1980s. In Bulgaria, all the settlements with infant mortality rates significantly above the national average are also places of special environmental concern. Infant mortality rates are above the national average in the mining districts of North Bohemia, especially in Teplice. But these regional variations might easily be explained by social factors. At present, only one multivariate study exists which properly takes these into account.

The study, by Martin Bobak, analyzed infant mortality from 1986-1988 in the 42 districts of the Czech Republic where ambient air measurements of sulfur dioxide, suspended dust, and nitrogen oxide were available. Sociodemographic data for these districts were obtained from vital statistics and from a survey done by the Federal Bureau of Statistics in 1978. The districts were divided into quintiles according to the sum of the annual geometric means of sulfur dioxide and suspended dust. The following table shows the relative risks, by quintile of this combined variable, for infant mortality, postneonatal mortality, post-neonatal respiratory mortality and low birth weight. Each analysis is

adjusted for the districts' mean income, mean savings, mean car ownership, proportion of illegitimate births, and the abortion rate.

Variable	Exposure Quintile				
	1	2	3	4	5
IMR	1.0	1.14	1.15	1.23**	1.38***
PNMR	1.0	1.24	1.37*	1.24	1.61**
PNMResp	1.0	1.37	2.01	5.67***	7.79***
LBW	1.0	1.02	1.02	1.02	1.18***

* p<0.05, ** p<0.01, *** p<0.001 (p trend <0.01 for each analysis)

These data show an air pollution effect which is concentrated, as one would expect, in mortality from respiratory causes. If each of the exposure quintiles represented equal numbers of live births, then approximately 15% of infant mortality and 50% of postneonatal respiratory mortality in the Czech Republic could be "attributed to" air pollution. Of course, there are methodologic problems with this analysis. The proportion of Gypsies in each district was not included as an adjustment variable, the other adjustment variables were all area-based and not person-specific, and the air pollution data was subject to many sources of error and uncertainty. Nonetheless, this analysis supports the contention that environmental pollution may be a risk factor for infant mortality in areas heavily exposed to sulfur dioxide and/or particulates.

Regarding adult mortality, the regions of Katowice, Lodz, and Walbrzysk in Poland and the mining districts of North Bohemia are those most likely to have had a direct environmental effect not based on exposures at work. In each of these areas there are concordant elevations of adult male and female mortality associated with high levels of pollution in air and other media. The mining districts of North Bohemia have been compared to the adjacent non-mining districts in order to identify the specific causes of increased adult mortality. Among both males and females, cancer mortality makes up most of the differential and the incidence rates for cancer of the lung, colon, and stomach are elevated. No other useful analyses are available on adult mortality due to regional, as opposed to local, pollution. In particular, there are none of the calibre of Bobak's work on infant mortality.

Widespread Exposures through Water

Human health problems from chemical exposures in drinking water have been documented in Hungary, Slovakia, and Bulgaria. The most widespread problem is nitrate pollution, which is a problem because of its potential for causing methemoglobinemia in infants. Methemoglobinemia is a form of chemical asphyxiation wherein metabolites of nitrate bind to hemoglobin in the red blood cells, stopping them from transporting oxygen. In Borsod County, Hungary, nitrate levels in drinking water increased during the 1970s, reaching averages of more than 200 mg/l in some water supplies. Ten cases of methemoglobinemia were reported in 1975, increasing to 44 in 1978. This was the peak year. Thereafter, programs to dilute high nitrate water supplies with water lower in nitrates were started, and children under 12 were provided with two litres per day of nitrate free water in polyethylene bags. Currently, the caseload has shrunk to 1-3 per year, but, as of 1990, bagged water was still being supplied because the nitrate levels in the water supplies is still high.

In Slovakia, there have been 2255 reported cases of methemoglobinemia, including 12 deaths, between 1971 and 1985. Between 1985 and 1990 there were 281 cases with one death. It is presumed that the principal routes of exposure are through breast milk and

drinking water, although high levels of nitrate have been detected in food as well. In Slovakia there is a voluntary prevention program in which pediatricians and obstetricians encourage parents to check the levels of nitrate in their home water supplies. The local hygiene stations have been analysing the water for free and recommending that those with high levels of nitrates buy drinking water for their newborns.

In Bulgaria, high nitrate drinking water is very widespread. Nine of 28 regions of the country have 10-year average levels over the standard, and virtually all other regions have some local water supplies which are similarly elevated. However, it was difficult to get credible information on methemoglobinemia in Bulgaria. One official claimed that there was none, but I had several individual cases described to me by other officials. Moreover, it was difficult to find out whether preventive measures were being taken, and, if so, what they were.

Problems with arsenic in drinking water exist in Bekes County, Hungary, and the Pazardjik region of Bulgaria. Some evaluation has been made of the public health impact in Hungary, but not yet in Bulgaria. In 1981, it was estimated that 450,000 inhabitants of 6 counties in Hungary were exposed to water above the standard of 0.05 mg/l. Of these, 270,000 were in 31 settlements within Bekes County, where the water averaged 2-3 times the standard. A study of children drinking this water showed that those with greater than 1 mg/kg of arsenic in hair had higher rates of arsenic melanosis, arsenic keratosis, intestinal colic, and other non-specific conditions than children with lower arsenic levels in hair. A community of 50,000 with high arsenic levels in drinking water was compared to a similar sized community with normal drinking water. It was suggested that heart disease mortality, spontaneous abortions, and stillbirths were more common in the exposed community than the control.

Specific Concerns of Local Areas

In addition to the five groups of environmental health concerns identified above, there are many others which appear to be unique to specific local areas. This may be due to the special environmental circumstances of an area or to the fact that the concern has not been studied as extensively as it deserves. Several of these are identified below.

***Congenital anomalies--**In the mining districts of North Bohemia, high rates of congenital anomalies have been reported from routinely-collected data. Evidence of an effect of the physical environment on rates of congenital anomalies has been difficult to come by in epidemiologic studies done in the West. But there are reasons to take the data from North Bohemia seriously. The reported incidence rates are more than double what one would expect, having risen during the 1970s as air pollution levels rose in the region. There are marked differences in rates of congenital anomalies by the occupation of each of the parents. Also, the environment has some unique features, such as polycyclic aromatic hydrocarbons in rainwater, which suggest that claims that there is a unique experience with environmental health problems deserve serious consideration.

***Occupational Disease--**In general, it was not possible to tell from the routinely-collected data whether or not occupational diseases were more prevalent in Eastern Europe than elsewhere. This is because the data is collected for administrative purposes that seem to differ greatly between countries. One would be specially interested in information on occupational cancer incidence or mortality rates, because these are often related to long-term, low-dose exposures to specific workplace substances. But very few useful studies have been done of occupational cancer in Eastern Europe. The best available study is an ongoing one of uranium miners in Czechoslovakia, which has shown significant excesses of lung cancer among miners first employed in the 1940s and 1950s. Similarly, at a uranium mine recently closed near Pecs, Hungary, there is reason to believe that

significant excesses of lung cancer may have occurred and will continue to occur among the former miners, since the exposures were in the relatively recent past. At this mine, and in coal mines in the region, the rates of silicosis provided to me by company managers were spectacularly high. For instance, the incidence figures quoted to me for the Anthracite Mine would give a miner a 50% chance of developing silicosis during his working life.

*Health Problems Related to Organics--Not much has been done to identify and evaluate the environmental health impact of volatile organics, polycyclic aromatic hydrocarbons, or halogenated hydrocarbons in Eastern Europe. The measurement methods and equipment have not been readily available to public health agencies and information on their potential health significance has not been widely disseminated. Where measurements of organics have been made, in North Bohemia, Slovakia, and certain locations in Hungary, they have been found, and in significant quantities. But there have been few human health outcome studies to accompany the measurements.

3. Hot Spots

The following section presents more detailed information on important hot spots in Central and Eastern Europe. The two most clear-cut hot spots are the Katowice region of Silesia in Poland and the mining districts of North Bohemia in Czechoslovakia because they are reasonably large in geographic area and population, and have multiple environmental health problems which, to varying degrees, affect all the people in the area. These areas will be described in some detail, followed by summaries of other local hot spot areas in each of the four countries in question.

The Case of North Bohemia

Table 1 shows the evolution of life expectancy over the past 30 years for males and females in the provinces of Czechoslovakia. It shows that life expectancy in North Bohemia has lagged behind the rest of the country throughout that time. The districts of North Bohemia are heavily represented among those with the highest mortality rates in the Czech Republic for lung cancer (as well as "all cancer"), cardiovascular diseases, suicides, infant mortality, respiratory disease, and "external" causes.

The physical and chemical environment is uniquely hostile. Anyone who visits the mining districts of Teplice, Usti nad Labem, Most, Decin, and Chomutov will witness the incremental effects of decades of open-pit mining and effluents from a variety of polluting industries with old technology and poor environmental controls. When home heating sources are combined with industrial emissions in these mountain valleys during frequent temperature inversions, high levels of sulphur dioxide exposure commonly occur. These exposures are not merely sporadic. Levels of greater than one thousand micrograms per cubic meter can be sustained, on average, for a day at a time or longer.

Evidence of the unique character of the environmental conditions in the mining districts is not hard to find. In addition to sustained high levels of sulphur dioxide, significant contamination of dust and rain water in the area have also been documented. Table 2 presents pollutants found in rainwater in Teplice. In addition to significant levels of the constituents of acid precipitation, measurable quantities of several toxic metals were found. Carcinogenic polycyclic aromatic hydrocarbons were found in measurable quantities in 60% of the rainwater samples collected. Although these data are given for Teplice, it would not be unreasonable to assume that they might apply in varying degrees to many other local areas within the mining districts. Also, they should be supplemented with

TABLE 1: Evolution of Life Expectancy by Province

Province	1960/61		Year 1970/71		1986/87	
	Male	Female	Male	Female	Male	Female
North Bohemia	66.15	72.20	64.58	71.89	66.12	73.76
West Bohemia	66.39	72.80	65.13	72.32	66.81	73.82
Middle Bohemia	67.36	73.24	65.90	73.23	67.11	74.62
South Bohemia	67.49	73.24	66.52	73.76	67.24	74.85
Prague	67.66	73.27	66.36	72.78	68.71	74.92
East Bohemia	68.17	73.76	66.82	73.59	68.35	75.23
North Moravia	67.30	73.50	66.16	73.16	67.00	74.56
South Moravia	69.04	74.40	67.16	74.19	68.38	75.67
Middle Slovakia	67.98	72.44	66.75	73.24	67.01	75.37
East Slovakia	68.44	72.58	66.30	72.88	66.59	74.90
West Slovakia	68.67	73.11	66.84	73.10	66.94	74.61
Bratislava	-	-	67.72	73.21	69.36	75.47

TABLE 2: Pollutants in rainwater, Teplice, 1989

	Average Concentration	Range	Deposition per hectare per year
pH	4.64	3.78 - 6.10	-
Hardness	0.25 mmol	0.1 - 1.0	-
NO ₃	5.13 mg	1.26 - 12.92	26 kg
SO ₄	19.05 mg	2.4 - 153.7	78 kg
ChSKMn	7.07 mg O ₂	2.96 - 15.6	36.8 kg
CL	3.23 mg	0.9 - 16.0	32.6 kg
Ca	6.47 mg	2.0 - 30.1	28.9 kg
Mg	2.84 mg	0.0 - 6.1	10.8 kg
Fe	0.08 mg	0.01 - 0.59	323 g
F	0.84 mg	0.17 - 5.60	1.1 kg
Pb	19.45 ug	3.4 - 83	107 g
Cd	0.812 ug	0.2 - 2.7	3.03 g
Zn	361.89 ug	71 - 1994	1.5 kg
PAH*	43.70 ng	3 - 119	153 ug

*Measured in 60% of samples

the observation that the whole region is dotted with poorly controlled toxic waste dumps whose effluents are likely entering the ground water and contaminating soil to an unknown degree.

Tables 3 to 7 present certain special health concerns of the mining districts compared to the non-mining districts within North Bohemia. Table 3 documents infant mortality rates which are higher in the mining districts than in Czechoslovakia as a whole. In Teplice the infant mortality rate of 17.2 per thousand live births is far above the national average. Low birth weights are found to be nearly twice as frequent in Usti and Teplice than in Jablonec, a non-mining district in North Bohemia. Sram reports that the frequency of congenital anomalies varied between 7.8 and 8.7% in Teplice and between 8.7 and 11.1% in Usti during the period 1982 to 1986 while in Jablonec, it varied from 6.0 to 6.7% between 1982 and 84. These data, published in a study by Sram, are both very intriguing and problematic. In any jurisdiction, the proportion of children with a congenital anomaly is difficult to estimate. Some investigators include only serious congenital anomalies, while others include trivial ones as well, such as small birth marks. Some congenital anomalies show up at birth but others take months or years to express themselves. When a congenital anomaly is present, there is great variability from physician to physician regarding whether or not this will be recognized and recorded in a way that can be used by future investigators. In the case of the study in North Bohemia, we are told that information about pregnancy outcomes was obtained from medical records at the maternity hospitals and that the diagnosis of a congenital anomaly was somehow verified at one year of age. It is not clear how this verification took place or whether or not biases crept in to the original recording of congenital anomalies from the maternity hospitals. However, lack of detailed information does not necessarily imply questionable data quality. Even if the methods used in this study were questionable, reported rates of congenital anomalies between 6 and 11% are higher than we would expect and certainly require concern and further investigation.

Tables 4 through 6 provide some information regarding occupational variations in the proportion of reported congenital anomalies. Table 4 shows 3 fold variations in the proportion of children with congenital anomalies among women in 6 occupations where significant chemical exposures might occur. However, because the number of children produced by these women was relatively small during the course of the study, the estimates of the proportion of congenital anomalies may be somewhat unstable. Thus, from a statistical standpoint, it is possible that these results could be explained by chance alone. Similar patterns are seen in Table 5 in relation to the proportion of congenital anomalies by paternal occupation. Once again, the highest rates of congenital anomalies are found in the occupations where the smallest number of children have been born (i.e. among printers). However, this methodological problem should not be taken to mean that the data are wrong, only that they are of an exploratory rather than an hypothesis testing character. Table 6 focuses on the district of Usti. It shows a rapidly increasing annual proportion of congenital anomalies between 1972 and 1980. This corresponds in time with a period of rapidly increasing air pollution in the region. However, changes in patterns of reporting congenital anomalies must also be considered as a possible explanatory factor.

Returning to Table 3, sections 4 and 5 present the relative prevalence of selected health problems among preschool and school age children in the 5 mining districts, and the country as a whole. Among pre-school age children, there appear to be consistent increases in the prevalence of a variety of chronic problems, including kidney, lung, allergy, mental disorders and skin diseases. A similar pattern seems to occur among school age children but with a slightly different combination of chronic health problems. These data are based on physician reports from compulsory medical examinations. It is not clear how standardized these examinations are, or whether or not physicians in different parts of the country might be more or less careful to report problems depending upon their

TABLE 3: Child Health Status in Teplice and other Mining Areas of North Bohemia

1. Infant Mortality Rates (1983-87)

CSR	13.1/1000
Five Mining Districts	14.9
Teplice	17.2

2. Frequency of Low Birth Weight (%)

	1982	1983	1984	1985	1986
Usti nad Labem	8.1	8.4	7.7	7.5	8.7
Teplice	8.3	8.3	9.2	7.9	6.5
Jablonec	5.5	6.5	4.3	-	-
CSR	-	-	4.7	-	-

3. Frequency of Congenital Anomalies (% of total births)

	1982	1983	1984	1985	1986
Usti nad Labem	11.1	9.7	9.9	9.1	8.7
Teplice	8.5	7.9	7.8	7.8	8.7
Jablonec	6.7	6.0	6.5	-	-

4. Health Problems among Preschool Children (%)*

	CSR	Five Mining Districts
Chronic kidney/urinary tract diseases	0.89	1.12
Nonspecific lung/airways diseases	0.54	2.90
Allergies	1.70	2.93
Mental illnesses & "defects"	0.53	1.06
Skin diseases	0.65	1.29

5. Health Problems among School Children (%)*

	CSR	Five Mining Districts
Chronic kidney/urinary tract diseases	1.42	1.68
Nonspecific lung/airways diseases	0.45	1.40
Allergies	2.00	4.09
Endocrine disorders	1.17	1.54
Skin disorders	0.73	1.09
Other chronic problems	0.92	1.79

*based on physician reports of compulsory medical examinations (1983-1987)

TABLE 4: Congenital anomalies and occupational exposure to mothers in Teplice and Usti nad Labem*

GROUP	N	C A (%)	Excess compared to Jablonec (%)
Non - Exposed	13,069	8.8	-
Printers	16	25.0	+184
Hair-dressing	61	11.5	+31
Gas production	63	11.1	+26
Agriculture	353	11.0	+25
Chemical Industry	279	10.4	+18
Hospitals	504	9.3	+11

TABLE 5: Congenital anomalies and occupational exposure to fathers in Teplice and Usti nad Labem

GROUP	N	C A (%)	Excess compared to Jablonec (%)
Non-Exposed	12,111	8.4	-
Printers	18	33.3	+296
Gas Production	91	14.3	+70
Chemical Industry	349	11.7	+39
Machine Industry	504	10.3	+23
Miners	1,111	9.5	+13
Medical doctors	190	7.4	-12

TABLE 6: Incidence of congenital anomalies in the period 1972-1981, Usti nad Labem

YEAR	N	% C A
1972	1995	3.2
1973	2206	3.3
1974	2630	4.0
1975	2347	5.9
1976	2213	7.2
1977	2118	5.8
1978	2079	7.0
1979	2056	8.2
1980	1647	8.4
1981	1526	7.6

TABLE 7: Nature school and hematological function in children from North Bohemia

Study I (436 children)	Variable	Before Nature School		After	
	Erythrocytes	4.621		4.870	
	Hemoglobin	123.1		128.4	
Study II (157 children)	Erythrocytes	4.51		4.71	
Study III (59-72 children)		One day before	End of stay	One month after	Two Months after
	Erythrocytes	4.175	4.291	4.167	-
	(% > I SD below norm)	36%	14%	-	-
	Hemoglobin	113.5	117.6	117.3	-
	(% > I SD below norm)	42%	15%	-	-
	Lymphocytes with active nucleoli	11.93%	4.84%	6.06%	7.07%

expectation of whether or not the children should be healthy. These are important factors to consider when evaluating data from routinely collected sources such as this. However, once again, this data provides a powerful basis for generating an hypothesis that environmental conditions may be influencing the health status of children in the mining areas of North Bohemia in a way which affects multiple organ systems.

Table 7 presents results of 3 different investigations into the influence of nature school on the hematological function of children in North Bohemia. The length of time that children spent at the schools and the precise locations are not given. However, in all three studies, the erythrocyte counts increased during nature school and the hemoglobin counts increased in the two studies where it was measured. Moreover, there is evidence that the gains are lost soon after returning to the home environment. Similarly, in Study III, the proportion of immature lymphocytes dropped dramatically during the time at nature school, only to rebound thereafter. It is possible that these changes have both environmental and nutritional influences. Thus, it could be suggested, as an alternate hypothesis, that a good diet during nature school is the key variable which improves the hematological status of the children. However, the pattern of widespread anemia is one which is also found in the Katowice area of Silesia in Poland, where environmental conditions are similar to those found in the mining districts of North Bohemia. Thus, it is not unreasonable to suspect that early childhood exposures to high levels of environmental pollution from multiple sources may have a chronic toxic effect on the blood forming organs.

In addition to concerns regarding hematological function, several studies have been carried out looking at growth and bone maturation in North Bohemia, polluted regions in the former German Democratic Republic, and in the Federal Republic of Germany. These studies demonstrated that, back in the early 1970s, high rates of delayed bone maturation (32 to 54% of children) were found in the polluted regions of each of the 3 countries when compared with controls. However, by the late 1970s this pattern had been eliminated in the Federal Republic of Germany. A descriptive study published in 1986 claimed that in North Bohemia there had been no improvement between 1974 and 1984. Unfortunately, the data actually presented in the paper were only for the Federal Republic of Germany, so I have seen no documentation of delayed bone growth for children in the mining districts from the 1980s.

Cancer incidence data comparing the mining and non-mining districts of North Bohemia show consistent differences between the two, with the mining districts demonstrating higher standardized incidence ratios for cancer of the lung/airways, colon, and stomach for both sexes and cancer of the uterus for females. If factors in the chemical environment were responsible for these patterns, the mechanism might either be a latent effect, wherein cancers and other chronic diseases express themselves after long-term exposures to specific chemicals or, instead, as the long-term sequelae of chronic toxicity during childhood. Data in Table 2 show that there is no lack of opportunity for exposure to known carcinogens in the mining districts. Moreover, the consistency in risk between males and females supports the hypothesis that a common exposure (i.e. environmental) factor is at work. But the mining districts have much higher divorce rates and higher proportions of Gypsies than the non-mining districts, which suggest that there are marked sociodemographic differences between the mining and non-mining districts. This problem was adequately handled in the analysis of infant mortality by Bobak, which was described earlier in this report. In that case, sociodemographic variables did not explain the differences in infant mortality by air pollution quintile. Similar analyses are needed in respect of apparent increases in adult cancer incidence rates in heavily polluted regions.

The Case of Katowice Province

Table 8 shows that airborne dust, NO_x, and lead levels in the major towns of the Katowice region of Silesia are high by international standards. The distribution of sulphur dioxide levels is also above that of Poland as a whole, but not as high as in North Bohemia. Nevertheless, none of the areas of Katowice listed in table 8 have sulphur dioxide levels which are as low as the highest found in Canada. A similar pattern exists for the mean suspended dust levels. In 1987, the range of annual suspended dust concentrations in Katowice ranged from 114 to 318 micrograms per cubic meter, while the highest recorded mean in Canada for October 1986 was 124 micrograms per cubic meter. For the year 1989, the range of concentrations in the Greater Vancouver Regional District was 10 to 53 micrograms per cubic metre. Similarly, the highest annual airborne lead level in a "hot spot" in Canada in the 1980s was .55ug/m³. Several locations in Katowice exceed this level, in one place by as much as five-fold.

Another example of how widespread the pollutions is concerns a study of mutagenicity in the urine of children living in certain areas of Katowice region. Mutagenic urine suggests that an individual has been exposed to biologically significant doses of substances which might be carcinogenic to humans. For instance, in the North American context, cigarette smokers have been shown to have urine which is capable of mutating bacteria. Similarly, hospital workers who formulate anti-cancer agents (which are themselves carcinogenic) sometimes are found to have mutagenic urine. The following table shows that urine samples taken from children in two heavily industrialized areas of Katowice were frequently mutagenic in one or another form of the well-known Ames mutagenicity assay:

<u>Region</u>	Percent of Mutagenic Urines among Children in Katowice			
	Bacteria TA98		Bacteria TA 100	
	<u>Unactivated</u>	<u>B-Gluk +S-9</u>	<u>Unactivated</u>	<u>B-Gluk +S-9</u>
I. B (a)P 100-228 ng/m ³ in air (1987)	22%	28%	16%	25%
II. B(a)P 50-228 ng/m ³ in air (1987)	20%	39%	13%	29%
III. B(a)P <50 ng/m ³ in air (1987)	4%	5%	8%	10%

By including the less exposed third group, statistically significant increases in the proportion of mutagenic samples were seen.

A large proportion of the garden plots in Katowice are adjacent to industrial areas which have been contaminated both by airborne deposition and the practise of liming the soil with inorganic industrial waste. A pain-staking evaluation of the soil quality in virtually every farm and garden plot in the most heavily polluted parts of Katowice has shown that less than 40% of the places tested were fit for unrestricted cultivation of edible plants, because of heavy metal contamination. 50% were found to be appropriate only for edible plants which tend not to concentrate heavy metals. Finally, at least 10% of the farms and gardens were found to be fit for cultivation of decorative plants only. Because of the persistence of heavy metals in soils, this is likely not a problem which will resolve itself with simple pollution abatement. Yet 70% of the food eaten in Katowice is grown there, and 50% of the land in the area is dedicated to agricultural use.

Table 8: Average concentrations of pollutants in atmospheric air in some towns of Silesia region in 1987

Town	Dust ug/m ³	S0 ₂ ug/m ³	N0 _x ug/m ³	Fluoride ug/m ³	Formal- dehyde ug/m ³	Pb ug/m ³	Cd ng/m ³	Cr. ng/m ³	Benzo() pyrene ng/m ³
Katowice	218	74	100	1.2	42	0.47	13	23	130
Bytom	279	48	131	1.6	13	0.60	17	26	162
Chorzow	293	70	94	1.3	8	0.83	26	36	258
Dabrowa Gorn.	318	36	110	6.3	39	0.75	30	31	138
Gliwice	178	42	92	1.5	11	0.30	8	13	66
Ruda Sl.	212	55	90	1.5	8	0.40	10	18	95
Rybnik	184	45	95	3.6	11	0.35	8	14	72
Swietochlowice	224	67	116	2.1	19	0.40	11	14	128
Tarnowskie Gory	209	112	126	2.0	16	2.60	77	15	96
Wodzislaw	192	75	175	4.8	28	0.2	4	15	95
Zabrze	174	49	78	1.9	12	0.31	8	18	117

Consistent with the areas of highest environmental pollution, relatively high mortality rates in the region of Katowice are in urban, rather than rural areas. In fact, in the period 1981-1985, urban life expectancies for males and females in Katowice lagged behind the national average for urban areas by more than one year, while the rural life expectancies were actually slightly higher than other rural areas in Poland. The increased urban mortality in Katowice is due to increased rates of mortality from cardiovascular diseases, cancers, and digestive tract diseases among males and females over 60 years of age. The similarity in the sources of excess for males and females suggests a common etiology and is consistent with the observation that Katowice had one of the highest sickness absence rates in the country from digestive tract diseases. These data are also entirely consistent with the high levels of environmental exposure to at least one known cancer agent (B(a)P), the heavy contamination of the food supply by industrial effluents, and the extensive contamination of the air with agents capable of stressing the cardiorespiratory system. Nonetheless, it is important to note that respiratory diseases per se do not appear on the list of sources of increased urban mortality.

In 1988, 28 percent of compensable occupational diseases in Poland occurred amongst Katowice workers who represented only 11 percent of the Polish workforce. Amongst these diseases, 25-30% were due to pneumoconiosis, which could contribute indirectly to increased overall mortality from cardiovascular diseases. Hepatitis (7% of cases) could contribute to mortality from digestive tract disease, while lead poisoning (10% of cases) could contribute to sickness absence from the digestive tract but not likely to mortality from that organ system.

Similarly, infant mortality rates by subregion within Katowice for six years during the 1980s correlated with dust fall ($r=.372$), as well as with ambient levels of lead ($r=.345$), tar (.329), phenols (.332), formaldehyde (.308), and benzo(a)pyrene (.176). No correlation was seen with sulphur dioxide, oxides of nitrogen, or fluoride levels, and no multivariate exposure model was constructed. Nonetheless, the individual correlations are provocative. If these represent one or more valid associations, they might be due to direct fetotoxicity, placental damage, or effects on the prenatal health status of the mother.

The best studied issue in Katowice province is lead pollution and its effects on children. Garden plots in Katowice are heavily contaminated with lead; with a modal range of 200-500ppm and a maximum of 8000ppm. Residential soil lead levels in the hot spots of Katowice are above and beyond the experience of much of the Western world. In three identified hot spots the average soil lead levels in the late 1980s were 1025, 2124, and 6449 ppm, respectively, with a maximum of 19,750! Soil lead levels are not an esoteric parameter. In North America, they are the principal determinant of high blood lead in children who are not exposed to lead-based paints. This is because young children (under the age of 5) tend to passively ingest approximately 100 milligrams of soil per day by direct contact or contact with house dust which has equilibrated with the outside soil levels through people bringing soil into the house on their shoes, etc. Thus, children in Katowice are potentially exposed both from food and soil, as well as through the air.

It is no surprise that the data in the following table shows very high distributions of lead among children and mothers in all regions of Katowice except Lubowice and Bojszow, which are relatively remote areas.

Place	Children		Mothers	
	Mean	%>35ug/dl	Mean	%>35ug/dl
Szopienice	26.7	17.8	21.1	12.2
Miasteczko Sl	24.7	16.6	21.6	14.7
Zyglin	26.1	21.8	20.1	9.7
Lubowice	12.7	0.0	10.6	0.0
Zabrze	18.9	3.2	15.9	3.5
Toszek	17.9	13.2	13.1	4.5
Bytom	15.2	10.0	15.5	5.1
Bojszow	12.3	0.0	11.5	0.0
Breziny Sl	22.4	13.0	17.6	6.9
Brzozowice	23.4	7.8	16.8	4.8

By way of general comparison, 15 micrograms per decilitre of blood lead in children is given as the "lowest adverse effect level" by the Centres for Disease Control in the United States. Levels above 25 micrograms per decilitre call for medical investigation, according to the CDC. Thus, in 5 of the regions listed in the table above, the mean lead level among the children was at or near the investigation level and all but 2 of the means were above the lowest adverse effect level.

Table 9 details a lead study that was done by the Academy of Medicine in Zabrze, on children living near the Miasteczko lead and zinc smelter in the early 1980s. Table 9a presents the age specific blood lead levels, which have an elevated distribution. However, it is important to note that several children with acute symptoms, who had been removed from the area, were excluded from the Katowice sample. These children had blood lead levels between 35 and 87 micrograms per decilitre, and thus the sample data from Katowice are conservatively biased. Another important characteristic is that the blood leads appear to peak in the age range of 7 to 10 in Katowice. In North America, blood levels tend to peak at age 3 or 4. This would suggest, indirectly, that passive ingestion of soil was relatively more important in North America as a source of exposure than in spots in Poland where both food and soil could, in theory, make a major contribution. Since the principal effect of blood lead in children is on the developing nervous system, this phenomenon of sustained high blood lead levels throughout childhood may be disproportionately important in terms of long term biological effects. Table 9b seems to support this point; showing a 13 point IQ gradient between children with the highest and lowest blood lead levels. Were these results to apply population-wide, they could have a significant effect on the prospects of Katowice children in their adult lives.

The children from the Miasteczko area also had a variety of other significant health problems, including anemia, digestive tract systems, electroencephalogram changes, chromosome damage, and problems with the peripheral nervous system. I was unable to find studies which systematically investigated these phenomena throughout Katowice. However, a physician from the sanitary epidemiology station had data demonstrating that, from the mid 1970s to the mid 1980s, the average hemoglobin level among children and mothers throughout the province was approximately 12.5 grams percent. This is approximately 2 1/2 to 3 grams percent below the expected level and, indeed, below the average for Poland. Thus, the high rate of anemia found within the sample of 231 children from the hot spot is likely indicative of a more general problem throughout the province. While lead can be a cause of anemia, it would be very difficult to attribute such a widespread phenomenon to this single source. Likely, this is evidence of interactive effects of exposures to several metals and other environmental toxins, perhaps mediated through

Table 9: Studies of Children in Katowice

(a) Blood Lead Levels

Age	Mean(ug/dl)	%>30ug/dl
1-3	17.3	6.5
4-6	20.1	7.1
7-10	25.8	20.9
11-15	19.3	2.6

(b) Lead and IQ

Blood Lead	N of Subjects	IQ
<20 ug/dl	94	111
20-25	59	105
26-30	53	105
>30	25	98

acidification of soils and loss of bio-availability of nutrients, but in ways which are very poorly understood.

Hot Spots in Bulgaria

The following data outlines the known environmental health problems in various communities in Bulgaria. Space limitations preclude providing many details about chemical exposures here.

Pernik

1. **Biological Monitoring (within 2 km of ferrous metallurgy plant)**
 - average blood Pb in adults approx. 20-40 ug/dl
 - average carboxyhemoglobin level =2.5% (std <1.0%)
2. **Morbidity Surveillance**
 - incidence rate of chronic respiratory diseases (chronic bronchitis, emphysema), allergic diseases (including asthma) and coronary heart disease "2-3 times above national average"
 - strong correlation ($r=0.78$) between dust levels in 14 areas of Pernik and their asthma incidence rates

Kremikovtsi

1. **Biological Monitoring (200 adults, >15 years old, near steel mill)**
 - average carboxyhemoglobin level =2.6% (std<1.0%)
 - polycyclic aromatic hydrocarbon metabolites = 100% of subjects
 - average blood lead in 125 men and women 16-60 approx. 25ug/dl
2. **Morbidity Surveillance (11 year time series, 1980-1990)**
 - Settlement 1: strong correlation of incidence rate of acute respiratory disease in adults with average annual SO₂ levels ($r=0.67$).
 - : strong correlation of incidence rate of asthma in adults with average annual H₂S levels ($r=0.84$).
 - Settlement 2: strong correlation of incidence rate of chronic bronchitis/emphysema with average annual phenol levels ($r=0.86$) and SO₂ levels ($r=0.79$).

Plovdiv Area

1. **Morbidity Surveillance (near lead smelter)**
 - Correlation of airborne lead levels with rates of anemia by local area is strong ($r=0.75$).
 - Average blood lead level in children approx. 14ug/dl in Plovdiv, 24ug/dl in Asenovgrad, and 33ug/dl in Kuklen
 - Statistically significant correlation ($r=0.26$, $p=.008$) between toenail lead levels and "WISC Verbal" test in sample of 108 children.
 - Average blood lead in four samples of adults approx. 23-36ug/dl in Kuklen
 - Statistically significant correlation between average annual SO₂ levels and incidence of asthma and chronic bronchitis

2. Contamination of food with lead, 1990/91
 - Food with MAC of 0.5 mg/kg:

tomatoes	0.76 (average)
potatoes	0.92 (")
 - Food with MAC of 0.4 mg/kg:

apples	0.78 - 0.80
grapes	0.75 - 1.47
cherries	0.66 - 1.10
strawberries	0.94 - 1.00

Srednogie

1. Biological Monitoring (sample of 120 near copper mine/smelter)
 - 23% of adults had blood cadmium levels above standard (1 ug/gram creatinine)
 - 68% of adults had carboxyhemoglobin levels above standard (1%).
 - Average blood lead in 107 adults approx. 25ug/dl
2. Morbidity Surveillance
 - Correlation of average annual SO₂ and H₂SO₄ levels with incidence rates of chronic bronchitis, asthmatic bronchitis, coronary heart disease, and flu.

Devnya

1. Morbidity Surveillance (in an area with fertilizer, PVC, power, and carbide plants)
 - incidence of reportable respiratory diseases is the highest in the country
 - incidence rates of flu, chronic bronchitis, allergic "rash", conjunctivitis, and asthmatic bronchitis among children and adults were elevated compared to control town "Georgi Traikov".
2. Large Sample Survey.
 - random sample of 2350 people matched by age and smoking status with 1000 people from Georgi Traikov.
 - performed validated questionnaires for chronic bronchitis and coronary heart disease symptoms; did chest x-rays and spirometry.

<u>Outcome</u>	<u>Devnya</u>	<u>Control Town</u>
morning cough	30%	12%
cough more than 3 months/year	15%	6%
cough 3 years in a row	8%	4%
sputum	20%	6%
sputum 3 years in a row	14%	6%
wheeze	14%	6%
chronic bronchitis	8%	4%
x-ray changes "characteristic of chronic bronchitis"	4%	0.5%

Dimitrovgrad

1. Sample Survey (near fertilizer plant)
 - 100 school children, age 7-14 years, compared with 100 age-matched controls from Harmanly.

--50% of children from Dimitrovgrad had decreased height, weight, and chest expansion for their age.

a. Spirometry--FEV_{1.0}

		Boys	Girls
Age 14	Dimitrovgrad	2557 ml	2308 ml
	Controls	3342	3169
Age 13	Dimitrovgrad	2344 ml	2050 ml
	Controls	2967	2525
Age 12	Dimitrovgrad	2233 ml	1933 ml
	Controls	2800	2433
Age 11	Dimitrovgrad	2020 ml	1709 ml
	Controls	2360	2082

b. Classification of children's developmental status

		Dimitrovgrad	Controls
Group I	normal development	18	72
Group II	slight changes	37	20
Group III	chronic, compensated disease	45	8
Groups IV/V	chronic disease with loss of function	0	0

Vratsa

1. Biological Monitoring
--38% of children surveyed in the Eliseina settlement of Vratsa had blood leads greater than 20ug/dl.
2. Morbidity Surveillance (near chemical industry)
--Day-to-day time series multiple correlation between air pollutants, meteorologic variables, and symptoms/diseases from morbidity surveillance system. This showed correlations between ambient SO₂, NH₃, H₂S, and/or NO₂ levels and the daily incidence of conjunctivitis/rhinitis, flu, rash, asthma, tracheobronchitis, and pneumonia.

Razlog

1. Before-After Study
--Morbidity surveillance system evaluated for period before pulp and paper mill opened (pre-1970) and for 1981-85, when it was operating, showed that the incidence of asthma in adults increased 13-fold and conjunctivitis increased 3-fold.

Ruse

1. Acute Health Problems (1986-87)
--increases in average number of reported cases on days with 'toxic fog' versus days without toxic fog:

asthma	107%
acute bronchitis	67%
flu	26%
conjunctivitis	85%

2. **Chronic Health Problems**
 - during construction of industry on Rumanian side (1976-80), asthma incidence was 407% of national average; after industry went into operation (1981-86), it rose to 724% of national average.
 - gross congenital malformations (from hospital neonatal registry)
 - 1982 - 27.5/1000 live births.
 - 1986 - 39.7/1000 live births.

Other localities in Bulgaria where respiratory problems and/or excess lead exposures have been reported are: Sofia, Kurdzhali, Jana, Gabrovo, Varna, Kameno, and Burgas. Hitherto secret uranium mines are found at Boukhovo, Beliska, Eleshnitsa, Daspat, Smolyan, and Sliven. High soil arsenic levels are found at Pazardjik and elevated nitrate levels are found in more than half of the population's water supply.

Hot Spots in Hungary

Inner Budapest

1. **Lead study (high motor vehicle flows)**
 - 58.6% of sampled children with blood lead >20ug/dl
2. **Nagytetny area of District 22 (8 major industrial point sources)**
 - children's health: compared to children in District 17, the prevalence of anemia 8 times higher, asthma 7 times higher, chronic bronchitis 10 times higher, and pneumonia 2.5 times higher

Borsod County/Miskolc

1. **Nitrates in drinking water**
 - number of methemoglobinemia cases has fallen to 1-3 per year since introduction drinking water in bags for children
 - within the county, the incidence rate of digestive cancers increases 2-fold between the areas with <90ug/l of nitrate in the water and those with >200ug/l
2. **Respiratory problems**
 - during the 1980s, the rates of reported asthma cases among 6-14 year olds rose rapidly in association with increasing mixed dust exposures from multiple chemical and steel industries
 - reported respiratory disease incidence rates have increased most in Kazincbarcika, downwind of a major chemical industry

Bekes County

1. **Arsenic in drinking water**
 - 230,000 people with drinking water arsenic levels >0.05 mg/l
 - child health study: children with >1 mg/kg of arsenic in hair had higher rates of bronchitis, tonsillitis, intestinal colic, arsenic melanosis, and arsenic keratosis than children with lower hair arsenic levels
 - adult health study: rate of myocardial infarction, spontaneous abortion, and stillbirth were reported to be higher in high arsenic communities compared to matched communities nearby with low arsenic in drinking water

Ajka

1. Respiratory problems in children (near aluminum smelter)
 - average monthly incidence rate of respiratory disease in children (upper respiratory diseases, tonsillitis, acute bronchitis, sinusitis, laryngitis, and asthma) was twice as high over a 2 year period than in a control town
 - "airways obstruction" on spirometry was twice as frequent for girls, and 3.6 times as frequent for boys in Ajka as in the control town
2. Adult mortality
 - mortality from chronic bronchitis, emphysema, and asthma were higher for men aged 40-59 in Ajka than in control town, and were increasing in incidence in Ajka faster than in the control town

Dorog

1. Respiratory problems in children (near power station and coal mine)
 - prevalence of asthma among children 0-14 was 3 times national average over a ten year period
 - correlation between average monthly sulfur dioxide level and monthly rate of newly reported episodes of "all respiratory morbidity" was 0.78, and, for chronic bronchitis, it was 0.83

Romhany

1. Lead study (near lead smelter)
 - 17.9% of sampled children with blood lead > 20ug/dl
 - IQ difference of 10 points between those with blood lead >25ug/dl and those <10ug/dl

Szolnok

1. Lead study (high motor vehicle flows)
 - 37.6% of sampled children with blood lead >20ug/dl
 - IQ difference of 3.5 points between those with blood lead >25ug/dl and those <10ug/dl

Hot Spots in Czechoslovakia other than North Bohemia

Central Bohemia

1. Regional observations
 - correlation of 0.67 between each district's rate of newborns "small for gestational age" and the proportion of the district's population living in areas of "poor" environmental quality; the analogous correlation for overall standardized mortality ratios is 0.64
 - children from polluted areas of Central Bohemia who were sent to nature school had reversible improvements in pulmonary function, immune function, and red blood cell counts
2. Neratovice and Kralupy
 - cumulative incidence of acute respiratory diseases (pharyngitis, sinusitis, laryngitis, tonsillitis, bronchitis, asthma, flu, and pneumonia), age 0-15, more than twice as high in these polluted towns as in control town over a 3 year period

3. Pribram (near a lead smelter)
 - average blood lead among sampled children approx. 35ug/dl
 - high intakes from food, as well as soil (see lead section, page 6)
 - psychometric deficits were found among children in high lead areas compared to unexposed controls

Slovakia

1. Regional observations
 - methemoglobinemia: high nitrate levels in soil and drinking water are widespread in Slovakia. 281 cases, with 1 death, between 1985 and 1990
 - Slovakia nutritional survey showed, incidentally, that hemoglobin levels in children were lower in polluted areas with good nutrition (e.g. Kosice) than in unpolluted areas with poorer nutritional levels (e.g. Trebisov)
 - widespread concern about PCB contamination from various sources. Average PCB levels in human fat range from 920-4105 ug/kg among males and females in Bratislava, Martin, and Trencin
 - persistent contamination of the Dudvah River, and its banks, with radionuclides after a major accident at the A1 nuclear power plant in 1977.
2. Ziar nad Hronom (near an aluminum smelter)
 - incidence of bladder cancer in the district surrounding the smelter is elevated
3. Horna Nitra (arsenic-emitting coal-fired power plant)
 - elevated non-melanoma skin cancer rates downwind of plant
 - some evidence of hearing loss among children exposed to arsenic emissions
4. Bratislava
 - correlation between ambient SO₂ levels in districts of Bratislava and respiratory disease incidence rates in a special study of Bratislava (r=0.51)
5. Michalovce (former PCB production)
 - mini-epidemic of Potter's syndrome (i.e. congenital under-development of the kidneys between 1975-80. Despite closure of the plant and the contaminated drinking water source in the early 1980s, PCBs in breast milk remain high (average in 1988-89 was 4.4 ug/kg of fat; maximum was >20 ug/kg)

Hot Spots in Poland other than Katowice

Krakow

1. Respiratory health
 - daily fluctuations in SO₂ levels correlate with physician visits for respiratory problems in downtown Krakow
 - prevalence rates of chronic bronchitis increase 2-3 fold among college students who move to Krakow from the countryside
 - a well-designed case-control study showed an increased risk of lung cancer for both men and women living in heavily air polluted parts of Krakow
 - a longitudinal study showed that, for men, declines in pulmonary function were associated with acid rain exposures in the community, as well as workplace factors and cigarette smoking

2. Other concerns
 - ongoing problem of fluorosis near aluminum plant, despite the fact that it has shut down
 - concern about intra-uterine growth retardation due to environmental pollution
 - rapidly escalating lung cancer, asthma, and thyroid disease incidence rates during the 1980s

Wroclaw-Legnica-Glogow-Walbrysk

1. Lead exposure
 - inadequately documented evidence of high lead exposure to children living near a copper smelter
 - evidence of very high food lead levels in Walbrysk
2. Other problems
 - inadequately documented evidence of widespread methemoglobinemia near a lignite coal power plant
 - other concerns inadequately documented

4. Recommendations

Czechoslovakia

The public health implications of environmental pollution in Czechoslovakia are complex. In certain areas of the country, widespread pollution seems to have led to public health impacts across contiguous districts. In other parts of the country, specific point sources of pollution seem to have had local effects on health status. Where there has been widespread environmental devastation, there is also evidence of high rates of divorce and low levels of educational attainment, which complicate our understanding of the influence of the physicochemical environment per se on the health status of the population.

One of the tremendous advantages which exists in Czechoslovakia, as it does in Poland and Hungary, is the existence of an agency structure with a reasonably clear mandate to identify, evaluate, and control public health problems related to the physicochemical environment. Across the country there are a series of district hygiene stations (127 in all) and 12 regional hygiene stations. At the regional stations, there are multidisciplinary teams interested in environmental and industrial hygiene, occupational disease, epidemiology, and laboratory sciences. In the Czech republic, this network is backed up by the multidisciplinary Institute of Hygiene and Epidemiology. In Slovakia, it is supported by the Research Institute of Preventive Medicine which, similarly, is multidisciplinary in character. My experiences at the Regional and District Hygiene Stations and at the respective Institutes were basically quite positive. I met many committed, professional people who understood their role and were trying to carry it out as effectively as possible. Collaborative centres with the World Health Organization and the International Agency for Research on Cancer have been developed in at least 7 areas of emphasis. The Institute of Hygiene and Epidemiology maintains 42 national reference laboratories and the Research Institute of Preventive Medicine has 19 such laboratories. However, the strength of this network is the traditional fight against infectious diseases. This was the principal thrust of public health efforts throughout the industrialized world until approximately 1970. At that time, questions related to the lifestyle, social, and

physicochemical determinants of health began to increasingly interest the public health community in the West. Issues of diet, cigarette smoking and the effects of industrial pollution (such as asbestos) quickly gained prominence. These developments have also taken place in Eastern Bloc countries, although to a much more limited degree. Thus, the level of sophistication in dealing with problems of bacteria and viruses appears to be much higher at the Institutes than it is for problems related to multifactorial chronic diseases and environmental pollution.

This latter weakness cannot be overstated. In Scandinavia, Britain, Canada, the United States, Australia, and New Zealand, chronic disease epidemiology has increasingly become the foundation of public health practise over the past 20 years. This trend has also had a strong influence in France, Italy and Germany, although not as great as in the former countries I have mentioned. Chronic disease epidemiology has made a large contribution to identifying physicochemical causes of cancer, neurological diseases, asthma, and other disorders, as well as being crucial in the study of lifestyle and social determinants of disease. It has given the public health sector criteria for assessing cause and effect relationships; methods to evaluate the validity and reliability of human health studies; methods to link health status data bases to health services utilization statistics, exposed populations, etc.; and ways to evaluate multifactorial influences on health status.

The impact of the relative underdevelopment of chronic disease epidemiology has been manifest in many different ways. It has undermined the validity of many of the studies claiming to demonstrate associations between environmental exposures and human health status. Many of the research studies I saw suffered from inadequate specification of the study sample, inappropriate numbers of study subjects, inadequate standardization of outcome measures, and inadequate accounting for confounding variables. All of these problems are addressed in basic post-graduate courses in chronic disease epidemiology throughout the West. Next, there has been a strong tendency to rely on biological monitoring rather than measuring health status directly. There has been an historical tradition of measuring changes in immune function or evaluating cytogenetic variables as indicators of occupational or environmental health problems. However, they should not be used as substitutes for studies which directly evaluate the health status of the population as it relates to their well being.

Studies, such as the cohort studies of radon exposed miners, have lung cancer mortality or incidence as an end point. These measures, as well as all other chronic disease outcomes, have an obvious public health significance. Next, studies which evaluate declines in respiratory function are valuable because they are reasonably valid predictors of the capacity of individuals to perform their activities of daily living in the future. Finally, measures such as blood lead level are useful because of their role as markers for problems in child development that have been well established. When it comes to the public health effort in relation to environmental pollution in Czechoslovakia priority should be given to these and other health status oriented outcomes.

Another consequence of the lack of development of chronic disease epidemiology has been the lack of development of a strategy for using routinely collected data. As it presently stands, there are many agencies collecting data which could be of tremendous relevance to a comprehensive strategy for evaluating health and environmental relationships in Czechoslovakia. The Institute of Health Information and Statistics produces data by districts on life expectancy and disease specific mortality. The census collects information on potential social determinants of health status. Others, whom I did not specifically identify, create the indexes of environmental quality and calculate the proportion of those living in environments of each different class. Disease oriented agencies, such as the Institute for Experimental Oncology in Bratislava, create registries of cancer incidence. Other agencies, such as the Institute of Food, have vast amounts of routinely measured data

on pollutants in the food supply. Finally, statistics on hospital utilization and visits to practitioners such as pediatricians, are being collected and recorded.

At present, there does not seem to be a group within either of the lead Institutes which has overall responsibility for integrating this information, evaluating it for its significance in environmental health, or proposing ways to modify and improve it for these purposes. Such an effort would require an institute or agency to be identified as having a leadership role in the field. It would require a willingness to engage in broad, multidisciplinary collaboration and require a good deal of statistical expertise. But an effective strategy for evaluating routinely collected data could serve as a way to identify problems which require further investigation with more specifically designed, analytical studies.

The specific actions I am recommending fall into two categories. The first are important issues which require further scientific investigation and the second are areas in which technical assistance might prove especially effective.

The issues which require further investigations are:

1. Specific cancers and chronic respiratory diseases need to be more comprehensively evaluated by local area in polluted parts of the country - Aside from the studies of radon exposed miners, I have not seen any other properly designed occupational or environmental cancer studies of either a case control or cohort design. Such studies need to be considered for the workers and residents in Ziar nad Hronom and other places in the country where exposures to known human carcinogens are ongoing. Similarly, more epidemiologically valid studies of adult chronic respiratory disease and respiratory disease in children need to be carried out in areas of moderate and high levels of air pollution. Such studies should employ longitudinal designs.

2. Blood lead studies among children need to be undertaken more systematically in areas with high traffic flows or industrial sources of exposure - At present, the only thorough study of blood lead status among children I have seen was from Central Bohemia. In Prague and many other parts of the country, the traffic flows are likely high enough to create local "hot spots" of high air and soil lead contamination. In these areas, children may be at risk of lead exposures sufficient to lead to neurobehavioural deficits. By evaluating traffic flows, the nature of industrial processes, and existing airborne lead data it should be possible to construct an inventory of potential high risk locations for targeted evaluation of children.

3. Broader, more systematic evaluations of the health status of children and adults are needed in polluted areas, such as the mining districts of North Bohemia, the area around the aluminum smelter at Ziar nad Hronom, and the area adjacent to the power station emitting arsenic in Homa Nitra - In these areas, as well as others which I have failed to specifically list, workers and citizens are exposed to multiple pollutants over the long term. Moreover, these may also be areas with a high degree with social disruption, low educational status, or otherwise be disadvantaged from the standpoint of health status. In such areas, it is necessary to develop longitudinal studies of children and adults which deal comprehensively with factors that influence health status. In other words, concerns regarding nutritional and socioeconomic influences should be considered concurrently with environmental influences; multiple health problems and outcomes should be considered; immunological and cytogenetic markers should be strategically employed within a framework of considering direct measures of health status; and extremely careful attention should be paid to sample selection, study design, and statistical analysis.

4. A comprehensive accounting framework needs to be created to assess the relative health risks of the various energy options open to Czechoslovakia - The centre for radiation hygiene at the Institute of Hygiene and Epidemiology in Prague has already proposed a series of studies which should continue the evaluation of lung cancer and add other causes of death among those exposed to radon daughters. Their counterpart at the Research Institute for Preventive Medicine in Bratislava has also prepared detailed proposals. These need to be expanded to account for potential health impacts from "cradle to grave" That is, health risks must be accounted for at all stages of the process; from the risks of mining to the risks of waste disposal. At the same time, estimates should be made of the morbidity and mortality due to the mining and burning of coal, as the country's main energy source. This would involve using existing studies as well as relying on new investigations of heavily air polluted regions of the country.

5. Long term follow-up studies are needed to assess the effect of some major occupational and environmental exposures of the past, such as the problem with PCBs in the water supply in the late 1970s and early 1980s in Michalovce and the trichlorophenol exposures to the cohort of workers at Spolana. Also, there is need for more systematic studies of environmental levels of volatile organic compounds and polycyclic aromatic hydrocarbons in targeted locations.

The following areas should be given further consideration as priorities for technical assistance:

6. Chronic disease epidemiology and biostatistics - This report has described in detail the problems in this area. There is a clear need for programs which strengthen the epidemiologic resources in the country and enhance their role in evaluating environmental health problems. One way to do this would be to organize intensive courses for existing personnel engaged in studies of health status and in statistical analysis. Such courses would involve bringing experts into Czechoslovakia from various parts of the world for a few weeks at a time in order to upgrade existing skills. Next, a strategically chosen group of individuals could be sent to study at schools of epidemiology and public health abroad. The numbers of individuals who could do this would likely be small, but these people would be expected to return and provide consultant services to their colleagues. Finally, the existing expertise in epidemiology could, perhaps, be better used by creating epidemiology consultation services within the existing Institutes. Here, epidemiologists with special skills would become a resource to an entire institute, rather than being seconded within a particular working group.

7. Equipment purchase - There are a large number of equipment items, reagents, and computer software needed to improve the measurement of environmental contaminants, human health outcomes, and statistical phenomena, which cannot be purchased at present due to lack of hard currency. For example, collection tubes, analytic equipment, and reference standards for blood lead levels; portable spirometers for field studies of respiratory function; and equipment to allow measurement of VOC's and PAH's in environmental media are all in extremely short supply. This is by no means a comprehensive list. However, the list of priority equipment purchases should be based on the nature of the health studies being planned as a result of this environmental health study. Also, it would be extremely important to identify a lead agency or agencies which will be responsible for the human health aspects of environmental pollution, so that they can organize the priority list of equipment to be purchased.

8. Data base development - validating existing data bases and exploiting their potential is both a project and an area for technical assistance. On the project side, the Slovakian Cancer Incidence Registry should be analyzed by occupational and residential characteristics to provide a surveillance mechanism for cancer risks by local area in

Slovakia. By way of technical development, other, less well organized aggregate data bases throughout the country should be upgraded so that they can be used for environmental health surveillance and for management of the health care system as a whole. This would best be accomplished by bringing in a team from outside to audit the existing data bases and consider the feasibility and ethics of using them as a resource for record linkage projects.

Poland

The principal environmental threats to the health of the Polish people would appear to come from gases and airborne particulates; whose effects occur through direct inhalation and deposition on soil. This latter medium becomes a source of exposure through bioconcentration of metals and organic substances in food and through passive ingestion of soil by young children. At this point the threats to human health from widespread problems with water pollution in Poland do not seem to be as great. This would likely be because of the effectiveness of massive chlorination of the water supply in controlling waterborne infectious agents and because tap water is not commonly used as a source of drinking water. The other main sources of exposure: liming of soil with industrial waste and using fertilizers high in metals (particularly that from Togoland) seemed to have ceased.

As of the autumn, 1989, the following recommendations were current for Poland. Despite some initiatives taken under the terms of multilateral technical assistance projects, most are still relevant in 1992.

1. The national programs of monitoring air quality, soil contamination, and food contamination should be supported and improved. A national quality control program needs to be put in place like the one found for occupational exposures at the Institute of Occupational Medicine in Lodz. Outdated and unfixable equipment needs to be replaced with newer equipment that can more easily accommodate continuous monitoring. Soil and food contamination studies need to be carried out in a more systematic way. In particular, soil studies like those done in Katowice, which comprehensively inventory soil used for crop growing, and communicate clear recommendations, should be seen as a methodologic standard. Food intake studies, like the 10-day sample studies sometimes done on Polish adolescents living full time in institutional surroundings, set a methodologic standard for monitoring foodborne ingestion of toxic metals.

2. Because of its significance as a respiratory toxin, ozone should be added to the list of routinely measured air pollutants. Also, more systematic data is needed on carcinogens in air and soil, especially polycyclic aromatic hydrocarbons (of which benzo(a)pyrene is the best example).

3. In order to effectively monitor changes in health status over time and between region, Poland needs to improve its data collection and reporting of certain vital indicators.
*Cause specific mortality rates are inadequately broken down by ICD classification. For instance, circulatory diseases and cancers need to be broken down into specific disease entities so that those which are potentially influenced by environmental exposures can be separated from those which are not.

*Birth weight data needs to be reported by local areas so that it can be related to local pollution and sociodemographic characteristics. It would also be helpful to report prematurity and "small for gestational age" (according to accepted nomograms), and to break down infant mortality into neonatal and post-neonatal mortality, with special emphasis on post-neonatal respiratory mortality.

*The regional cancer registries throughout the country need to be brought up to the standard of the Warsaw Registry so that cancer incidence data can be compared across the country.

*At present, occupational diseases are being reported in a manner which is reasonably useful for integration into a national system of health statistics. With regard to the data on over-exposures to certain chemical agents, these need to be reported by region. The sickness absence program is potentially a very high quality resource, but needs to be converted to a person-based system, from a medical-encounter based system, in order to be useful.

*Blood lead measurement in childhood is an extremely useful health indicator because lead has known low dose effects, is easily measured, has been demonstrated to improve steadily in response to environmental cleanup programs, and represents a significant problem in the industrialized hot spots of Poland. Thus, the uncoordinated collection of child lead data needs to be replaced with a systematic surveillance program in regions of high soil and airborne lead.

*Chronic bronchitis and asthma are the two respiratory outcomes worth monitoring in adults. It is relatively easy to standardize the diagnosis of both of these entities using questionnaire and simple spirometry methods which could allow ongoing sample surveys throughout the country. Results from such surveys could form the basis of regional comparisons and analysis of time series.

4. One major problem in Poland is the lack of adequately trained chronic disease epidemiologists to initiate properly designed studies and generally insure that reliable and valid population health data is being used in decision making. To address this problem, there need to be a combination of upgrading programs for staff who are early in their careers at relevant institutions (e.g. san-epi stations, Institute of Hygiene, Institute of Occupational Medicine, etc.) and graduate school opportunities at major epidemiology centres in the West.

Hungary

In general, the environmental health problems of Hungary appear to be a series of local problems and not, like Poland or Czechoslovakia, a matter of widespread devastation of large areas. (A partial exception may be the pollution of drinking water with arsenic and nitrates). The process of identifying, evaluating, and controlling important environmental health problems is complicated by the barriers to communication and cooperation which we encountered during our trip to Hungary. So far, these problems have lead to a chaotic situation in environment and health data collection, in which certain agencies are much farther ahead than others in developing surveillance methodologies; there is a lack of widespread consensus on what the major problems really are; many of the central agencies in Budapest lack credibility in the local regions; and data which is available is questioned (and is often simply not made public to begin with).

The following suggestions are all within the technical capability of the various Institutes associated with the National Institute of Hygiene, and, in general, are extensions of existing activities. However, the likelihood that these activities and others like them will make a contribution to solutions to the public health problems of environmental contamination in Hungary depends very much on the breaking down of institutional barriers we encountered on our trip. Specific initiatives which need to be considered are :

1. A series of activities to validate and improve routine data collection, including
 - a. validating the cancer incidence reporting system, making it computer-based, and reportable by local area.

b. validating the respiratory disease reporting system, ensuring comparability of diagnosis across the country, and ensuring that the quality of the ancillary reporting of welfare and drug costs remains high.

c. in particular, consideration given to helping support the plan to integrate regional air pollution data with the pediatrician based respiratory morbidity reporting system for children.

2. Exploitation of some extremely useful "natural experiments" in Hungary, as well as giving support to existing national centres of excellence. In particular, for approximately for \$15,000 per year, the National Birth Defects Registry can be analyzed by maternal occupation, down to the workplace level, for groups of specific diagnoses. Because of the availability of pregnancy logs, drug histories and maternal illness can be accounted for as confounders.

3. Some of the occupational health problems in Hungary require special consideration. In particular, the cohorts of workers from the coal and uranium mines in Pecs need to be carefully followed to ascertain complete mortality and morbidity status, so that the cost of caring for them and compensating them can be adequately integrated into energy policy decisions. Another group which urgently requires study is the cohort of aluminum workers from Ajka. From what I have been told, a planned study was either never done or was suppressed. Because of the well known problems among aluminum smelter workers in the rest of the world with respect to bladder cancer and flourishes, it would be very important to evaluate this group.

4. Both the childhood and adult cohorts of arsenic exposed people in Bekes County should be subject to long-term follow-up. Such a follow-up has been planned for children but, at the time of our visit, the funds were unavailable to carry it out. Because the follow-up work is primarily labor intensive, the costs will be quite inexpensive in US dollar terms.

5. Another long term follow-up study which should be initiated involves the workers and residents at Paks. This nuclear power plant went into operation in 1983 and so it is much too early to see any evidence of long-term, low-dose radiation impacts. But now is the time to create a registry of individuals potentially exposed to power plant emissions. If there are to be public health impacts, they will probably not start to emerge until the end of the first decade of the 21st century. At that point, going back and identifying all those who have worked and lived near the site will be much more complicated than if a careful registry is maintained on a prospective basis. In relation to workers, this registry should integrate any personal dosimetry which is currently being carried out.

6. Although lead exposure among children is an important issue in Hungary, the determinants of childhood lead exposure have not been studied in a systematic way. In urban and industrial areas, studies are needed in which blood samples are taken from children by microtubule, and soil, air, dust, paint, water, and vegetables are collected concurrently and analyzed for their contribution to those with high lead levels. For instance, in Budapest it is clear that children living in areas of high airborne and soil lead levels have high blood lead. But it is not clear which of these two sources is most important in determining what their blood lead levels are. If, as if in North America, soil and dust turn out to be the major mediators of increased lead levels in children, then programs of soil remediation will likely be just as important as control of lead emissions from gasoline in the ultimate solution to the problem. Also, in carrying out lead studies, the urinary ALA-D approach to lead measurements should be abandoned in favor of blood samples by microtubule and soil digestion methods should be made comparable to US EPA methods. At present, adequate equipment is the limiting factor in initiating such studies.

7. Data collection regarding polycyclic aromatic hydrocarbons, volatile organics, and other chlorinated hydrocarbons appears to be very uneven in Hungary. Because of the importance of these substances as emissions from automobiles and industrial sources, it would be important to improve the quality of data collection. At "Environment and Health in Eastern Europe", it was suggested that there was limited knowledge about the pollutants produced by the two-stroke automobile engines and how to monitor them. This is certainly a priority area to address. As well, I was struck by how little work had been done monitoring hydrocarbons in Borsod County. Here the number of point sources of exposure is very large, and yet all the public health work was based on interpretation of exposures to metals, largely because these other substances simply have not been measured.

Bulgaria

The human health problems associated with environmental pollution and contamination in Bulgaria are primarily concentrated around facilities such as steel mills, smelters and chemical and fertilizer plants. In these areas the most credibly documented health problems are lead over-exposures among children and acute and chronic respiratory diseases among children and adults. In some cases there is also evidence of growth retardation among children. Less well documented, but worthy of careful scrutiny, are suspicions of: elevated infant mortality, congenital anomalies, certain environmentally-sensitive cancers, cardiovascular diseases, and sickness absences from work as a result of environmental conditions.

The secondary route of exposure to the public is through food; the principal concern being metals in crops grown in soils which exceed the standards. Relatively high levels of lead in food throughout the country have been documented, although it is not clear whether or not this route of exposure, by itself, could lead to elevated blood lead levels in children.

The quality of data linking health to environment is highly variable and routes of exposure have been documented in a very fragmented way. Airborne exposures, contaminated food and drinking water, and soil exposures need to be assessed in a coordinated fashion. Similarly, all special studies and routinely collected health/vital statistics data need to be retrievable according to the rough geographic boundaries of the polluted areas. At present, there are several obstacles to achieving these goals. These are:

- a) A large number of Institutes in different Ministries and Academies have interests in particular aspects of the total exposure-health outcome issues. They have not coordinated their efforts very well.
- b) There is no consensus on what the leading "environmentally-sensitive" health conditions are.
- c) Geographic regions for data collection range from 28 (Ministry of Health) to 16 (Ministry of Environment) to 9 (Central Statistics). This impedes the use of routinely-collected data to identify areas of concern.
- d) Open acknowledgement of environmental health problems is relatively recent so routinely collected health data have not been organized in a way which facilitates environmental health evaluations. The most practical example of this is that cancer incidence data did not start being computerized by the specific address of the patient until 1990, despite the fact that address data has been collected on routine reporting forms since 1970.

These observations imply certain short-term priorities, as follows:

1. There should be a program of total ecological and health evaluation of polluted areas, based on collaboration between all the Institutes which have interests in the field. This would be the most efficient way to mobilize resources and characterize risk.
2. There is a need to create easily accessible summaries of environmental exposure and health data for the country, probably using maps, so that complete and timely information can be made available on equal terms to policy-makers, scientists, and concerned citizens.
3. There is need for a technical assistance program to help improve the quality of environmental epidemiology; increase expertise in exposure/risk assessment methods; add more rigor to quality control activities in the exposure and health data collection; and raise consciousness in the field of risk communication.
4. There is need for a new generation of multifactorial studies in certain polluted areas to help clarify whether or not health problems other than lead overexposure and respiratory disease are, indeed, being caused or exacerbated by environmental exposures.
5. There needs to be a policy/legislative framework which will lead to primary preventive activities (i.e. environment cleanup and emission controls) when credible evidence of human health effects of environmental pollution are put forward.
6. A system of peer review needs to be established for research initiatives in public health related areas, in which the rationale, design, sampling, and analysis of specific studies are set out clearly in advance of funding being made available.
7. Lead overexposures in children and respiratory diseases in children and adults should be targeted as leading environmental outcomes for priority-setting. Multi-factorial studies of lead overexposures can and should be conducted to determine the relative importance of food, soil, dust, and other sources of lead in children.
8. Certain registries, such as the cancer incidence registry, the system of recording medical visits, and the registry of compensated occupational diseases should be carefully validated and upgraded. These registries are potentially an important source of information on human health impacts of industrial pollution, but each has limitations at present which reduce their value. The cancer incidence registry would be the easiest to upgrade, because it is the best conceived and maintained at present. In particular, specific address information should be computerized back to 1970 and sufficient hardware, software, and personnel made available to conduct analyses of selected cancers by local area.

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