

Air pollution: the valuation of morbidity

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Abstract

The aim of this article is to present the various methods used to value health costs. In cases where the method used to value the cost of an illness only reflects the “social cost” (medical expenses and loss of income), we recommend that it be supplemented by the contingent valuation method, which is designed to value the “private cost” (inconvenience, suffering, restricted activity). We illustrate the complementary nature of both methods by presenting the results of a case study on the valuation of benign illnesses due to air pollution in Strasbourg, France. In our study, the private cost accounts for an average 50% of the total cost incurred by illness: The private cost is therefore a major component which should not be omitted when valuing public health protection policy.

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Current epidemiological research (Lebowitz, 1996; Pope and Dockery, 1991, 1992; Schwartz et al., 1991; ERPURS, 1987-1992) raises the question of how to value health costs incurred by air pollution. Indeed, valuation is meaningless if no correlation is found between morbidity and air pollution. However, even if air pollution generally constitutes only a minor health risk, health costs may be considerable as the entire population is exposed. The economic valuation of health costs then becomes a challenge, insofar as public health protection and the reduction of public expenditure are priorities in terms of public decision-making. A cost-benefit analysis would be an effective means of making environmental policy decisions more consistent with public preferences. The difficulty lies in the valuation of benefits derived from the policy, generally assessed on the basis of avoided costs. Consequently, improvements in air quality would result in a reduced number of hospital admissions for asthma attacks and the benefit would be quantified by valuing the costs of each avoided hospital admission. Considered from this angle, all benefits derived from the policy must be factored in and the most reliable valuations must be obtained.

In the same way as most epidemiological studies deal with the acute effects of air pollution, most economic valuations concern themselves with the short term. Even if the emphasis is placed on short-term health effects, their wide variety (mortality, serious and benign morbidity) requires the application of several valuation methods, as they are too varied to be assessed as part of a single survey.

Up until now, the majority of valuations fail to incorporate benefits due to benign symptoms, mortality accounting for virtually all benefits (approx. 85% according to Masson and Willinger, 1996, approx. 97% according to Rabl, 1999 and 95% according to Chanel, 2000), while morbidity is only reflected in hospitalization costs, treatment costs and sick leave. Estimated morbidity figures are low, as the costs incurred by inconvenience are not accounted for. In order to make a full assessment of health costs, it is important that the latter costs be factored in. Particularly in the case of benign morbidity, the incorporation of these costs is essential, as treatment costs are particularly low, not to say non-existent. A study by Soudan (1992) shows that in the case of benign respiratory illness, the rate of self-medication stands at 50%. The research discussed in this article was conducted with two objectives in mind: The one was to demonstrate that benign morbidity should not be ignored, because in spite of its minor effects on health, it does affect the whole population. The other was to show that the costs incurred by the inconvenience, suffered as a result of illness, should not be omitted from

the valuation of health-care costs and may be significant. In order to fully assess benign morbidity costs, two studies were required: one designed to value treatment costs and the other to value costs incurred by inconvenience.

The methodology used to assess treatment costs is a conventional economic method used to calculate accounting costs, based on the commercial value of a good. Within the scope of health-care cost-assessment, one of the methods used is that of illness costing. Costs incurred by inconvenience cannot be valued by means of this method, as inconvenience does not have a commercial value. Contingent valuation is the most appropriate method, whereby individuals reveal their preferences for the commodity in question, i.e. an improved state of health brought about by improved air quality. Our study was conducted in Strasbourg. We will be discussing both health-care cost-assessments, i.e. illness-costing and inconvenience-costing, respectively.

Strasbourg, study location

We chose to conduct our study in Strasbourg for a number of reasons. To begin with, Strasbourg has been home to an air-quality monitoring organization (ASPA) since 1978. In addition, the Greater Strasbourg Area was the subject of an original epidemiological study on benign symptoms (Eilstein et al., 1999). In 1996 and 1997, a group of 22 general practitioners kept a systematic record of symptoms, which was then compared with atmospheric concentration data. Recorded symptoms included sore and itchy eyes, runny nose, sore or red throat, earache, coughing, hoarseness, wheezing and other respiratory disorders, and headaches. Results were not yet available at the time of the health cost assessment (Rozan, 1999), but the ideas exchanged during the establishment of an epidemiological study protocol (Eilstein et al., 1996) were helpful to us. Since then, the results of the epidemiological study have confirmed the existence of statistically significant short-term links (0 to 5 days) between air pollution and benign symptoms, with the exception of earache.

Medical and social cost assessment

In our attempts to quantify the costs incurred by illness, we were confronted by the problem of data collection. Some epidemiological studies, such as ERPURS [1997], do not discuss the impact of air pollution in terms of morbidity but rather in terms of induced effects (number of emergency doctor consultations, number of days in hospital, number of days off work), that can be assigned a direct monetary value.

Not having access to such information, we conducted a survey among experts, in order to find out about the effects caused by the various illnesses. We chose to focus on illnesses because while it is impossible to provide a therapeutic strategy on the basis of a symptom, it is possible to do so on the basis of a symptom within a pathological context. Illnesses were selected so as to reflect the list of symptoms included in the epidemiological study. Because the illnesses are of a benign nature, the experts are general practitioners and we used the doctors surveyed in the epidemiological study.

Expert survey

Our survey is based on the Delphi methodology (see Schmöder [1988]). The latter is often used to value medical processes when quantitative information is lacking (see Weinstein and Fineberg [1980]). The technique consists of questioning experts without mentioning any names. If responses converge, the profile is used as a reference. If responses differ, a new questionnaire is given to the experts, in addition to a summary of the previous responses. Experts are able to modify their response. Iterations are stopped when the responses stabilize.

The questionnaire

The questionnaire asks experts to describe their therapeutic strategy (standard prescription, number of days of sick leave, prescribed additional examinations, special treatment, number of consultations) for each illness and each group of patients. The questionnaire was sent out on September 2nd 1998. Doctors who agreed to fill it in sent it back within 10 days. In total, 13 general practitioners and 3 pediatricians took part in the survey.

There was a high level of convergence with regard to prescriptions, with the exception of one doctor practicing a particular form of medicine (homeopathy). Convergence was essentially observed in the groups of medicines.

Cost-assessment methodology

To begin with, the cost of each prescription was calculated on the basis of prescribed doses and the prices given in the 1998 issue of VIDAL. We took into account the full cost of treatment, including expenses incurred by the packaging of medicines. The average prescription cost was then obtained by taking the average cost of each prescription.

Costs incurred by doctors' fees were calculated on the basis of agreed rates charged by general practitioners at the time of the survey (1 consultation = 115 F and 1 examination = 135 F). In the case of consultations with other specialists (eye specialists, lung specialists), we based our calculations on the agreed rate, i.e. 150 F. Costs are under-estimated in cases where a specialist charges his own rates.

AMK5-rated physiotherapy sessions for breathing disorders are calculated on the basis of the current rate, i.e. 65 F per session. X-ray examinations were calculated on the basis of figures provided by the June 1998 issue of the Journal Officiel (Government Gazette), using a Z index value of 10.95 F for electro-radiologists and gastro-enterologists. Allergy tests are generally required for an initial asthma attack. In such an event, the range of tests is fairly wide, costing 250 F on average. Subsequently, if the tests show that the patient is indeed allergic, more specific tests may be conducted at an average cost of 450 F.

Hospitalization costs have not been factored in. Patients are very seldom admitted to hospital for the type of illness included in our study. The only instance in which a patient may be admitted would be in the event of an asthma attack. However, the attack described in the questionnaire is relatively benign (severe breathing difficulties, decrease in flowmeter reading, wheezing) and only very seldom results in hospitalization.

Costs associated with a patient's time off work have been significantly simplified. We assume that in 100% of cases, adult sick-leave concerns salaried employees. In the case of non-salaried workers, we assume that the appropriate sick-leave is not taken for the illnesses in question, as it leads to a total loss of income. In the case of people who do not work (unemployed, at home), we work on the premise that no additional costs are incurred, even if these people are forced to curtail their activity. The table of results shows costs with and without a wage loss, the cost incurred by time off work being calculated on the basis of the net average wage, i.e. an average daily cost of **356 Francs**, according to the French statistical register (INSEE 1998). In France, individuals do not have their wages cut (for the first three days, they receive their full wage and if they are off work for longer, social security takes

over). This social cost would then correspond to a production loss. This could be estimated on the basis of GDP/person. Again, taking the same wage into account, costs could be underestimated. Let us remember that while our aim is to estimate the benefits derived from an improvement in air quality, our chosen criteria tend to favor under-estimation as opposed to over-estimation.

Costs associated with school absenteeism are based on the average expenditure for a child's education. In our questionnaire, we have only taken under-fives into consideration, and include expenses for pre-school and primary school education. On the basis of 155 school days per annum, the daily cost incurred by school absenteeism is **147 Francs**. This technique provides an estimate of the cost, as other costs likely to be incurred by a child's illness are not taken into account (child minding, for instance).

In the case of the elderly, costs incurred by curtailment of activity (bed rest) have not been calculated. These illnesses seldom require the presence of a nurse at home to administer care, at least no more so than the engagement of a medical service at home.

Results

A standard profile was established on the basis of convergent responses. On this basis, for each illness and each patient group, we calculated an average cost. In the case of adults, the "total cost" column shows two estimates. The second estimate does not factor in the cost incurred by time off work.

Valuation of medical and social costs incurred by various respiratory illnesses due to air pollution (Adult columns show cost with/without time off work)

	Adults	Weakened adults	Children (<5 years)	Elderly people
Laryngitis	185 F	230 F	201 F	191 F
Conjunctivitis	151 F ^a	162 F ^a	157 F	157 F
Ear infection	1276 F / 208 F	2022 F / 242 F	780 F	215 F
Throat infection	185 F	1627 F / 203 F	203 F	188 F
Sinusitis	2096 F / 316 F	2491 F / 355 F	671 F	295 F
Early bronchitis	1253 F / 185 F	2010 F / 230 F	220 F	200 F
Advanced bronchitis	2526 F / 390 F	4014 F / 1166 F	1483 F	685 F
Asthma attack	1805 F / 381 F	2541 F / 404 F	1210 F	982 F

^a Possible cost increase due to consultation with eye specialist (+150 F)

This estimate of the medical and social costs incurred by illness is an approximate value, which tends towards under-estimation (low-cost scenarios). Furthermore, assigning a standard

prescription to each illness and patient group is tricky, as each case is unique. Consequently, responses apply to a majority of cases.

Finally, our study does not incorporate children aged over 5 years. This group was considered unnecessary in terms of treatment, because the treatment of a (weakened) child aged 5+ years resembles that of a (weakened) adult. The cost incurred by school absenteeism in the case of secondary and high-school pupils is 277 Francs (Statistical teaching and educational references, 1997).

Valuation of costs incurred by inconvenience

It is difficult to value the cost of inconvenience, as there are no commercial values available for direct use. Contingent valuation seems to be the most appropriate method.

Contingent valuation method

The contingent valuation method (CVM) was first applied by Davis (1963), in a study entitled *The value of outdoor recreation: an economic study of the Maine Woods*. Contingent valuation breaks with other, previously used methods, by basing itself on the observed preferences for hypothetical variations in the quality of an environmental commodity. By virtue of its specific nature, it is used to estimate unobservable values, such as that attributed to the possibility of visiting a natural reserve, the conservation of an animal species, air quality, etc. The uniqueness of this method accounts for its unprecedented popularity, primarily in the United States and later on, in Europe. It is, however, subject to a certain number of biases (Mitchell & Carson, 1989), which have given rise to a full-blown polemic within the scientific community. Following the wreck of the Exxon Valdez oil tanker, the method's relevance and validity became the subject of considerable debate. The American courts finally acknowledged the method, on the proviso that the latter complied with the N.O.A.A. Panel's recommendations (Arrow et al., 1993). These recommendations primarily concern the methodological choices of the questionnaire and the organization of the survey (e.g. choice of a "closed" question for revealed preferences; face-to-face interviews, etc.).

While a relatively large number of contingent valuation studies have been conducted on the health benefits derived from improved air quality, those concerning benign symptoms are relatively few. This contingent study is the first in France to assess the cost of inconvenience incurred by morbidity.

Morbidity cost studies can be divided into two categories, according to the information given to the respondent at the time of the survey. We distinguish between studies which do not specify the causes in the questionnaire, and studies which explicitly specify a symptom's causes (air pollution). Rozan and Willinger (1998) showed that the same effects on health are assessed differently depending on their respective causes, thereby resulting in discrepancies of 20 to 30%. We may think that such a discrepancy does not reflect irrational behavior on the part of individuals. When air pollution is referred to specifically, some people are willing to pay more, as they expect that they and their families will reap the benefits of better health. This reaction is particularly common when the individual has children. When we conducted sample interviews (preliminary questionnaire tests), we first asked individuals what they would be willing to pay for an improved state of health. We then repeated the question after explaining that this improvement would be brought about by a reduction in air pollution. People whose WTP was non-existent or very low then revised it upward for altruistic reasons. Furthermore, it appears that "suffering from a symptom" and "suffering from a symptom due to pollution" do not reflect two identical states. Individuals tend to be more willing to pay for a reduction of symptoms due to air pollution. The reasons given are that air pollution is perceived as a negative external factor (undergone risk), which is not the case with other possible causes (time (fate), tobacco (chosen risk)). We have therefore chosen to specify the cause of symptoms in the questionnaire.

Contingent valuation questionnaire

The questionnaire was developed over a period of time. At different stages of its design, sample interviews (Schkade & Payne, 1993) were conducted in order to validate our choices as well as the respondents' comprehension. When drafting the questionnaire, we followed the NOAA Panel's recommendations (Arrow et al., 1993). We also collected the respondents' social and economic characteristics (age, gender, socioprofessional group, household income, etc.).

The individuals valued a reduction in the occurrence of certain symptoms selected from a list of ten, generally matching those used in the epidemiological study (sore and itchy eyes, runny nose, sore throat, earache, cough, hoarseness, breathing difficulties and headaches). In order for individuals to familiarize themselves with the commodity in question, they began by describing their state of health and that of their family members (children, spouse, parents) over the past two months.

The contingent scenario is divided into two phases. The individual is first asked to state whether he/she is willing to take part in an air pollution abatement program, by choosing one of two options:

- Option 1: You retain the current air quality. This option does not incur any financial costs, but it does not improve your state of health either.
- Option 2: You make a financial contribution to an air quality improvement program. This option incurs financial costs, but also improves your state of health.

This choice states the issue clearly. In the majority of contingent surveys, the individual must immediately state his willingness to pay (WTP), something he may be reluctant to do if he is unwilling to pay. Individuals having chosen *option 1* give their reasons for this choice. One of two versions of the scenario was offered to respondents having chosen *option 2*. The text of the scenario is given in the box below. Respondents make their assessment after listening to a description of the program (N.B. implementation of the program implies a contribution from everyone) and being informed of the payment method (an annual fee in this case). Two treatments were applied, their differences lying in the risk reduction probability factor, i.e. a 50% or 30% reduction. In both cases, a second program is suggested and the respondent states his WTP once again. Both treatments were designed to test the premise that WTP would increase as the program became more effective.

Contingent scenario

Treatment 1 (*Treatment 2*)

A large number of the symptoms discussed (show list again) are due to air pollution. If air pollution were reduced by half (*by a third*), the frequency of symptoms directly linked to pollution would also be reduced by half (*by a third*) over the next 5 years. You are willing to make a financial contribution to the air quality improvement program. The program will run over a 5-year period, everyone will contribute, and the money collected will be managed by the air quality monitoring agency. We would like to know the maximum amount you are willing to pay to take part in this program. Remember that you will be making annual contributions over a 5-year period. We would also like to point out that the money you invest

proportionately diminishes your income and consequently, your ability to spend on other items.

To help you decide on the maximum amount you are willing to pay in order to take part in this program, we are going to ask you a number of simple questions, to which you will answer YES or NO.

The respondent was then asked a series of "closed" questions in which several amounts were suggested (example: "are you willing to pay at least 100F in order to take part in the program?"). The questions were designed to establish the range of the individual's WTP. This was followed by an "open-ended" question:

So you agree to pay at least...(lower limit) but no more than... (upper limit). Lastly, what is the maximum annual amount you are willing to pay, bearing in mind that you can still change what you have just told me?

And now, supposing that in the next 5 years, pollution is not reduced by 50% (30%) but only by 30% (but by 50%). Symptoms due to pollution would also be reduced by 30% (50%). What annual amount would you be willing to pay, in that case?

Various methods have been devised in order to obtain the individual's stated preferences. These can be divided into two main groups, depending on whether the questionnaire is closed or open-ended. In the case of an open-ended question, it is the individual who determines the level of WTP. This technique has the advantage of not influencing answers, but it raises the issue of the obtained value's relevance, as individuals are not accustomed to 'constructing' values. The other group of questions ("closed") has the advantage of depicting a typical consumer scenario, i.e. a price is suggested and the individual decides whether or not to buy. Its disadvantage lies in the fact that the assessment is not independent of the amounts suggested to the individual. We tried out a new revelation technique on the basis of contingent valuation, which attempts to compensate for the disadvantages inherent in "closed" questions. The technique entails determining a WTP range, proceeding by successive approximations (series of closed questions), followed by a final open-ended question. The answer to the open-ended question is taken as being the individual's WTP.

Sampling

Because the whole population is intrinsically concerned by benign symptoms, the selected sample is representative of the population residing within the Greater Strasbourg Area, i.e. 422 849 inhabitants (1990 population census). The survey took the form of a face-to-face interview with passers-by. The sample, comprising 1000 individuals, is representative of the population residing within the Greater Strasbourg Area, per age, gender, socioprofessional group, household size and residence quota. Interview length may vary from 10 to 20 minutes

(depending on the individual's answer to the question regarding his participation in the program).

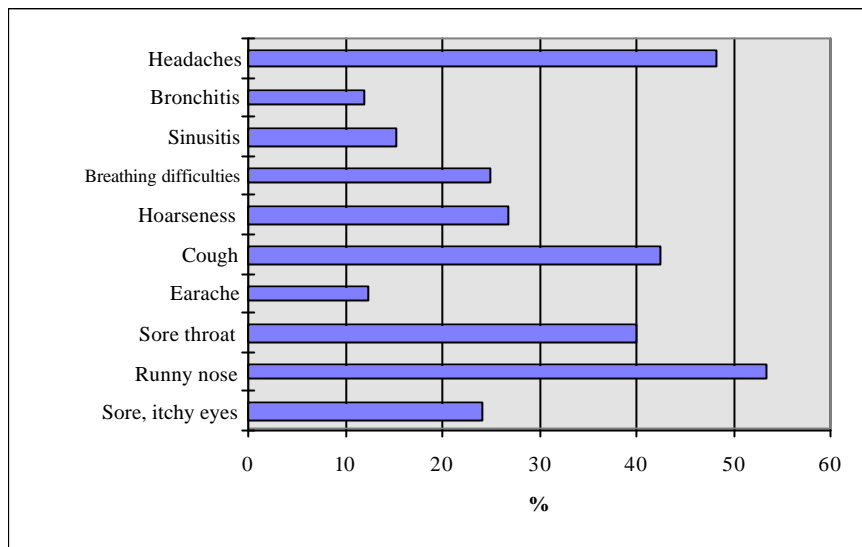
The survey took place from the 12th to the 23rd of January 1998. Twelve interviewers were commissioned to keep down the survey duration, in order to curtail risks associated with contextual variation, i.e. political and economic environment. The survey was deliberately conducted during the period of winter pollution, the latter not being subject to extensive media coverage, as opposed to summer pollution, where benefits might have been overestimated.

Results

All respondents reside within the Greater Strasbourg Area. 59.1% of the sample population live in Strasbourg. The average age is 41 years (those interviewed were older than 18). 53.5% of respondents are women and the average household consists of 2.6 members. The median income of sample households is around 10 000F.

During the first phase of the questionnaire, the respondent describes his/her state of health and that of his/her family. 83.7% of respondents claim to have suffered from at least one symptom in the two months preceding the survey. These individuals have been affected by 3.6 symptoms on average. The most frequently suffered symptom is a runny nose, followed by headaches.

Incidence of symptoms during previous 2 months



Only 7.4% of interviewees suffer from asthma, while 6.56% have asthmatic children. However, sore and itchy eyes affect over 20% of the population. Many people complain of suffering from conjunctivitis more and more frequently, or simply of having sore eyes.

Interviewees indicated the length of time (number of days in the past 60 days) during which they were affected by the symptoms. The median varies from 7 to 10 days, all symptoms considered, with the exception of headaches, where it stands at 5 days. Headaches are also the symptom that troubles most people (26.4%), followed by a runny nose (19.24%), coughing (11.23%) and breathing difficulties (10.39%). Respondents do not confuse the inconvenience suffered and the duration of the symptom. Less frequent symptoms include earache, bronchitis and sinusitis.

Of those people having been affected by at least one symptom, 10% were prevented from working, 20.4% gave up leisure activities, 42% consulted a doctor, 42% took prescribed medicine and 45% took over-the-counter drugs (self-medication). Some people took prescribed and over-the-counter drugs at the same time. Lastly, 55.7% of these people incurred a financial cost without social security reimbursement, the average cost standing at 108F per person.

While 96.2% of respondents generally think that the air pollution issue is a serious one (61.8%, really serious and 34.4%, fairly serious), 59.6% perceive pollution's effects on health as a nuisance. Discomfort due to odors is also mentioned, while visibility and plant welfare are virtually not.

Let us remember that the contingent scenario is divided into two phases. To begin with, the respondent chooses between two options. 44.7% of respondents refused to take part in the program. Although this percentage is particularly high compared with other contingent valuations (approx. 20%, according to Mitchell & Carson, 1989), we feel it reflects more closely the realities of actual financial participation. When giving the reasons for their refusal, most respondents claimed that they did not think they were polluters and should not therefore have to suffer the financial consequences. Furthermore, they felt that they did not have sufficient financial means in order to take part. The table below summarizes the reasons given by individuals for refusing to take part in the program.

Reasons for refusing to take part in the program

Reasons	% having given this reason
I do not have the means to pay	32%
It's not a serious problem	10%
I don't have enough information	13%
I don't pollute. The polluters must pay	40%
Paying doesn't help	19%
It's the government's responsibility (better distribution of the budget)	10%
I don't want an additional tax	18%
I think that individual actions are better	6%
I don't have an opinion	4%

We conducted a statistical analysis in order to identify the variables that influence decisions to take part in the program. Age-related variables were identified: younger people are more willing to take part in the air quality improvement program. Among these variables, two others are directly related to air pollution: the belief that the air pollution issue is really serious and obtaining information on air quality. Women are more willing to take part than men. Lastly, people with a higher level of education are more inclined to take part in the program than others.

Finally, variables indicating whether an individual or his/her family member has suffered from one or more symptoms have a positive or negative effect on his/her probable participation in the program. The fact that some symptom combinations might negatively affect willingness to take part in the program is not surprising, as only 55.3% of the sample group is willing to take part in the program, while 83.7% of the individuals have suffered

from at least one symptom. Among those having suffered from symptoms in the last two months, those who are unwilling to pay in order to take part in the program may have various reasons:

- The person does not reject the scenario in which air pollution is responsible for some of the symptoms, but does reject having to pay:
 - (i) The person feels that the program should be funded by taxation;
 - (ii) He/she feels that the symptoms are not sufficiently troublesome for him/her to pay for the program;
 - (iii) The person feels he/she is only the victim and not the polluter;
- The person does not believe the program will succeed;
- The person identifies another cause (allergy, tobacco, migraine).

The following table shows the average observed WTP:

Average observed WTP

Treatment 1	50%	Confidence range at 95%	30%	Confidence range at 95%	Number observed
Av. WTP	698	[611 ; 783]	615	[535 ; 695]	303
Treatment 2	30%		50%		
Av. WTP	623	[533 ; 725]	652	[556 ; 748]	250

The hypothesis claims that respondents are able to incorporate different risk reduction probabilities. The test entails checking whether the discrepancy observed between the average WTP levels for both improvement probability factors is significant with two different groups of people, the first having assessed a 50% improvement program, and the second having assessed a 30% improvement program. The average WTP levels do not differ significantly; people do not see much meaning in the 30% and 50% levels.

For econometric WTP processing purposes, we have taken into account the fact that only a portion of the population agreed to take part in the program.

The majority of significant variables which account for the individual's WTP, are indicative of the symptoms. Familiarity with the ASPA seems to be a factor that has a positive effect on WTP. Income is also a significant variable, and has a positive effect on WTP.

Valuation of overall morbidity costs

These two studies are complementary, as they are designed to establish the total cost incurred by an illness. The average WTP calculated using the contingent valuation method may be

considered as an approximation of the inconvenience suffered during a bout of illness, in the case of the various respiratory disorders. The average length of the episode is relatively short, approx. 3 to 7 days, and we may assume that the cost incurred by inconvenience is not proportional to the number of days. WTP would supplement the medical and social costs.

Costs incurred by inconvenience account for a significant portion of the total health-care cost. In the case of benign morbidity caused by air pollution, this result is even more pronounced. Indeed, as some of these disorders were not followed up by a visit to the doctor (58% of interviewees having suffered from symptoms did not see a doctor), the effects would be completely obscured by an approach based exclusively on the medical and social costs.

Finally, within the scope of benign morbidity, we may conclude that the costs incurred by inconvenience account for an average 50% of the total cost incurred by the illness. It is not easy to deduce any rules for general cases of morbidity. Indeed, benign morbidity is a special case, where medical and social costs are low, treatment is inexpensive and the inability to work is rare. In the case of more serious illnesses requiring extensive medical treatment, hospitalization and long periods of sick leave, the medical and social costs will be higher. However, the suffering and inconvenience incurred will also be greater. Contingent valuation studies conducted upon targeted individuals should provide an estimation of costs incurred by serious morbidity, while indicating its proportion in the overall cost of the disorder. We are not currently aware of such valuations. However, given the results obtained in the area of benign morbidity, it appears that the costs incurred by inconvenience cannot be ignored. A valuation of health-care costs that fails to factor in the latter would lead to an under-estimation of costs incurred by morbidity. From the perspective of a cost-benefit analysis, an under-estimation of this kind could modify resulting conclusions and public choices.

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