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Morbidity due to Air Pollution in Cotonou: An Assessment of the Psychological Cost

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Abstract

Atmospheric pollution is a negative externality whose health costs are significant. In this article we assessed the psychological cost or cost of suffering due to pollution-related morbidity. The Contingent Valuation (CV) method has allowed us to estimate the average monthly psychological cost of disease for a household head based on the Willingness To Pay (WTPs) of household heads to halve air pollution in the city of Cotonou. This assessment is one of the few in the city of Cotonou or even in West Africa. The analysis of the WTPs with a Tobit model has allowed us to derive the average WTP, which represents the psychological cost of morbidity whose value is estimated at FCFA 1,200/month per household head. This result can validly serve as the basis for decision-making in line with the polluter pays principle.

Keywords: Atmospheric pollution; Morbidity; Contingent valuation; Psychological cost; Generalized tobit

JEL classification: C34, I18, Q51, Q53

Introduction

Pollution is a major concern for most countries of the world. The issue of pollution is at the heart of the theory of externalities whose basic foundations are clearly laid by Pigou. Populations exposed to atmospheric pollution suffer enormous damage. The effects of this pollution on human health are the major concern in most studies that have examined the issue. Thus, Raffin [1]showed the relationship between health, environmental quality and economic development. The definition of air pollution according to Tattersfield [2], which was taken over by Nejjari et al. [3] is: 'contamination of the air by one or more substances that are either produced naturally, or result from human activity, with the consequence that the air becomes less acceptable for maintaining health'. From this definition, it is understandable that human health is threatened. This explains why studies in this area in most African countries or elsewhere focus more on the effects of air pollution (AP) on health. It is noteworthy that recently, Hunt [4] actually restated that the effects of AP range from no less important breathing problems to cases of death due to cardiopulmonary diseases. Similarly, the report on "the perceptions of indoor air pollution in Île-de-France" also specifies the effects of pollution on health.

For environmental economists, attention is often paid to the assessment of damages related to air pollution. Thus, morbidity and/or mortality profits or costs are assessed through various works [1,5-8]. It is noteworthy that two cost components allow a full assessment of the damages associated with morbidity due to air pollution: the medical-social costs and the cost of suffering or discomfort associated with the morbid condition. Indeed, Rozan [9] showed that the cost of discomfort or psychological cost is as important as the second one. But some studies (e.g. [6]) were only based on the assessment of the medical-social cost which takes into account the total expenses for treating the disease, the loss of income related to the inability (due to disease) to conduct income-generating activities, etc.

Faced with the reality of air pollution in the city of Cotonou, residents of the latter undergo health costs due to this nuisance. Given that obtaining a zero level for air pollution is almost impossible [1], the populations are exposed to the adverse effects of air pollution. In these atmospheric pollution conditions, victims would incur health expenses either for preventing diseases or for treating them. This would cost a lot to the population from a health perspective. Some expenses would be incurred to avoid premature death. Kappos et al. [10] noted that short-term studies on air pollution have shown that the relations between concentrations of dust particles (PM) and human health become less significant for low levels of concentrations. Apart from the respiratory tract, the cardiovascular system is threatened by pollutants. For this reason, there is an increase in cardiovascular pathologies or the worsening of pre-existing ones. We can also observe other symptoms outside airways such as eye irritation, headache, fatigue etc. Recently, Just [11] showed that in developed countries, when one is exposed to air pollution in youth, there is an increase of allergies and the incidence of asthma. It remains true that chronic diseases and cancers affecting the respiratory system often appear in areas with high levels of pollution. Long-term effects are more difficult to study because of their low intensity. These various works thus confirm the potential costs faced by the peaceful population being exposed to air pollutants.

Whatever the disease caused by air pollution, the affected individual suffers from it, and so depending on the severity and duration of pain. This suffering is not without consequences in terms of costs for the individual. It is these costs that Rozan [9] terms cost of discomfort or psychological cost. So what is the level of psychological cost [private cost] due to air pollution in Cotonou?

So far, no assessment of this type of cost related to air pollution has been made in Cotonou. This assessment is one of the few in the city of Cotonou or even in West Africa. The objective of this article is to assess the psychological cost of morbidity due to air pollution in the city of Cotonou in Benin. To address this concern, the article is structured as follows. In the second section, we discuss the literature and in the third section, we present the methodology used for the assessment of

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the cost. The penultimate section presents results and discussions and the final section concludes.

Literature Review

Several studies have examined the question of morbidity related to air pollution [AP]. To this end, they have sought to assess damages or costs related to morbidity due to this pollution. We highlight in this section a number of works in order to take advantage from them for our assessment in the case of the city of Cotonou. First, it should be noted that in the assessment of morbidity due to air pollution, two main approaches dominate in the literature: The dose-response function (DRF) approach and the contingent valuation approach. The health production function (HPF) method approach used by Gerking and Stanley [12] seems not to have as much application in the works as the two other approaches. With this study, these authors derived an average WTP which is between $18.45 and $24.48 for a 30% reduction in ozone concentrations. To do this, they conducted a survey on a sample of 824 adults in St. Louis. The collection of information on air quality, use of medical services, prices of medical services, wage rates, sociodemographic characteristics and measurements of health stock, helped these authors make their assessment.

Regarding the dose-response function (DRF) method, it should be noted that the studies that have made use of it [13-16] were based on time series. Some of these studies [13,14] have used daily data. Based on a case study in London, Maddison [14] analyzed hospital admissions as well as PM_{10}concentrations while Laïd et al. [13], based on health variables, applied the DRF method in the city of Algiers. For assessments of this kind, the results are in terms of number of attributable cases. For example Maddison [14] found that a 1% reduction in PM_{10} levels causes a significant reduction of 0.14% in the number of respiratory hospital admissions. In a similar vein, other studies were based on annual or international data [15]. These studies took into account pollution indicators such as black smoke, fine particles, NO_2, O_3, SO_2 as well as health and socioeconomic variables. Another study, remaining in the same logic of number of attributable cases, showed that increasing pollutant from a basic level to a median level causes an increase of at least 2% of hospitalizations for each type of disease respectively. By cons, Rabl [15] found that a 10% reduction of pollutant concentrations saves 67 million of disease-related cost. These results reflect again that diseases due to air pollution cause significant costs. Whether in terms of attributable cases or monetary value, the assessment by the DRF method gives important information on morbidity costs associated with air pollution. Also, it should be noted that a study conducted in the United States [16] using the same method, was based on epidemiological and clinical data. The first allowed the authors to obtain a benefit of $ 250 million for a reduction of air pollution, and the second led them to a benefit of $ 800 million.

As for the contingent valuation method, it has had many applications since its first use in the United States by Davis [17]. This approach consists in proposing to the agents a "contingent market" in which they are asked to make a choice, the purpose of this being to determine the WTP of the surveyed individual. Thus, the studies discussed in this review [5,6,9,18] were based on field surveys. Indeed, a contingent valuation questionnaire is necessary in the conduct of such research. The various studies carried out in this context take into account socioeconomic, demographic and health variables. Thus, Alberini et al. [5] considered in their study, variables such as the nature of the disease, the length of time during which respondents have suffered symptoms, the severity of the disease, the sociodemographic characteristics. In addition to the socio demographic variables used by Chanel et al. [6], the medical expenses and the loss of income were included. Unlike other authors, the study of Rozan [9] was concerned with benign diseases due to air pollution. Also, it should be noted that she took into account variables such as prices of medicines, hospitalization costs, costs of consultancy fees, work stoppage and school absenteeism costs, as well as the socioeconomic characteristics of individuals. In these various works, the size of the sample used is not the same. The size is 262 in the work of Alberini et al. [5], 864 in that of Chanel et al. [6], and 1,000 in that of Rozan [9]. In all these studies, the WTP served as a basis for deriving the economic benefit or the economic cost. According to Berger et al. [18], the WTP increases with the pain of the disease and it has a value of $ 27 for one day spent suffering from a cold, and a value of $ 108 for a day without headaches. The economic benefit obtained by these authors totaled $ 6.79 for the case of colds and $ 3.45 for the case without headaches. Still in terms of benefit, Alberini et al. [5] found that following a pollution reduction, the value of morbidity is about US $ 262.58 million. The WTP to avoid the disease increases with the duration of the disease, the number of symptoms experienced, education and income. By cons, according to Chanel et al. [6], the morbidity costs of air pollution reach 67.8 billion francs. Rozan [9] found in her study that the average WTP amounts to F 282 and corresponds to the psychological cost of the disease. The psychological cost she obtained represents at least 50% of the total cost of the disease. She also assessed the medical-social costs per pathology [185F for Laryngitis/weakened adult]. It is noticeable that in the work of Rozan [9], a distinction is made between the psychological cost [or cost of discomfort] and the medical-social cost. And for the latter, she used the Cost-of-illness method (COIM).

It should be noted that the variables which the various authors cited above have referred to, are virtually those mentioned by Gastineau et al. [19]. Moreover, very few studies have examined the specific assessment of the psychological cost (or cost of discomfort) due to air pollution.

Cost Assessment Methodology

Sampling

In this paper, we proceeded by empirical survey. According to Ardilly [20], there are two main types of empirical surveys: -the quota method and -the standard units method. The quota method is the most frequently used empirical method. According to Gauthy-Sinéchal and Vandercammen [21], this method is based on the following assumption: *if the sample accurately reproduces certain characteristics of the study population, it will also be representative for other non-controllable characteristics but which are the very subject of the survey*. For them, the challenge in this method is to accurately determine the variables to retain, and to find in the population the exact proportions of units having these characteristics.

The sample size chosen for this purpose is 600 individuals. This size corresponds to an absolute error of about 4%. In the city of Cotonou, 74.10% of men are heads of households and 25.90% are female heads of household, out of a population of 426,220 men and 436,225 women in 2010. Account is taken of the proportions of men heads of household per area in Benin and the Littoral department (Cotonou), as well as the data of Cotonou city hall on motorcycle taxis according to which about 47.06% of men heads of household are motorcycle taxi drivers. These drivers are more exposed to atmospheric pollution because of their activity. In fact, this is also confirmed by the various research studies conducted for the city on those drivers.

The statistical units which make up the sample were randomly selected using the door to door method in the eight districts in which industrial activities are dominant in the said city.

Survey methodology

In a CV assessment method, the questionnaire is fundamental. Thus, the questionnaire was developed taking into account the main biases inherent in the method. These biases highlighted by Mitchell and Carson [22] have recently been synthesized by Bontems and Rotillon [23]. These include the strategic bias, biases related to the administration of the questionnaire, the hypothetical bias and the effect of inclusion. An effort was made to minimize the different biases.

Firstly, in the questions asked, the recommendations of the NOAA Arrow [24] have been followed. So the questions are mostly closed questions, and they are followed by some open questions at certain points. Also, the scenario described is understandable by the population which is well familiar with the problem of air pollution. To assess the cost of suffering associated with the morbid condition of individuals, the part of the questionnaire which takes into account this aspect is split into three sub-parts. The first sub-part relates to characteristics of the respondent (sex, age, educational level, socio-professional category, marital status). The second sub-part contains on the one hand, questions related to the morbid effects and those that highlight the households' perception of AP; and on the other hand questions about revealing the WTP based on the discomfort felt by the respondent. Regarding this section on the WTP, the scenario described is presented in the box below. Whatever the choice made by the respondent based on the scenario, he is asked an additional question about his maximum WTP. The third sub-part deals with other characteristics of the respondent (monthly income, being a smoker, energy sources used, and some household expenses).

Then the questionnaire benefited from the informative remarks of economicsand demographicsexperts. The contributions of health economics and environmental economics experts are rewarding. It should be noted that the questionnaire was read and corrected by the expert on field surveys, Bernard Lacombe. According to the methodological approaches to field practice which we have taken inspiration from in the work of Lacombe, the questionnaire has improved. After taking into account the various comments, the final questionnaire was used for the training of the surveyors recruited for the occasion. Finally, a pre-test was done to ensure the population's understanding of the questions. The various end-of-interview reports from the pre-test showed that respondents actually experience the phenomenon of air pollution through the nuisance it creates. These reports have allowed us to elaborate on how certain questions should be approached during the administration of the questionnaire permanently retained.

Box: Contingent scenario

Everyone has the right to breathe clean air. Yet, it has been shown that there is a relation between air pollution and the occurrence of the listed diseases such as: coughing, headaches, respiratory diseases, heart diseases, sore eyes, asthma etc. The risk of experiencing these diseases again can be reduced through a comprehensive program to fight against the degradation of air quality. This will allow improving and preserving the health of the population.

We have two cases:

***Case 1**: The air quality in Cotonou deteriorates. In this case, your health condition deteriorates because of diseases related to air pollution, and you remain without response by bearing no financial cost; but the air quality does not improve.*

***Cas 2**: You agree to help fund an air quality improvement program. Here you bear a financial cost but the occurrence of certain diseases will lessen and your health will improve as well.*

Which of the two cases do you prefer?

***If choice = Case 2**,*

We present you the following scenario:

Many of the diseases that you have suffered are due to air pollution. If pollution is reduced by half over a period of 5 years, the risk of suffering from the ills directly related to pollution will be halved too.

Will you be ready, during the 5 years of the project, to pay a monthly amount of at least [show the payment chart]: FCFA 500, FCFA 1.000, FCFA 1.500, FCFA 2.000, FCFA 2.500, FCFA 3.000, FCFA 3.500, FCFA 4.000, FCFA 4500, FCFA 5.000, FCFA 5.500, FCFA 6.000?

***If choice = Case 1**, what are the reasons for your choice?*

After the administration of the 600 questionnaires, 584 have actually been processed because of some unanswered questions. Therefore, the response rate is 97.33%. The database used in the econometric analysis traces the information on the 584 individuals processed.

Description of variables

In the works on the use of the CV method for assessments of this kind [9,25], the variables that are often taken into account are those relating to socio-economic and demographic characteristics on the one hand, and those relating to the specificities of the property to be assessed on the other hand (here, there are variables related, for example, to the health status, the fact of visiting a doctor, etc).

The main variables relevant to the estimation of the average WTP representing the psychological cost are the socio-economic variables of the respondents. We considered the following variables:

- The monthly Willingness To Pay [capmois] is a discrete quantitative variable whose values appear on the payment chart[according to the contingent scenario: FCFA 500, FCFA 1.000F, FCFA 1.500, FCFA 2.000, FCFA 2.500, FCFA 3.000, FCFA 3.500, FCFA 4.000, FCFA 4.500, FCFA 5.000, FCFA 5.500, FCFA 6.000]. This is the dependent variable.
- Sex [sexe] is a dichotomous variable. It has only two

modalities [1=0=Male and 0=Female].

- Age [age] is a continuous variable. Its modalities depend on the respondent's bygone age expressed in years. As the age of the individual increases, he is tempted to contribute more in order to have good health, to a certain degree. Note that according to Phelps the individual's health condition deteriorates with age, and so he gives more importance to his health in old age; therefore he tends to contribute more than a young man.

- Age squared [agecar]; it is a variable that takes into account the nonlinear effect of age. Beyond a certain age threshold, the individual's income decreases and the effect of age on the capmois becomes negative. It is fair to say that an individual who is aging has a low labor productivity compared to a young person, and therefore his income may be low; so his WTP may decrease.

- Duration of residence [tempshabit] is a continuous variable describing the number of years spent by the respondent in the city of Cotonou. An individual who has spent a long time in the city of Cotonou has the chance to make comparisons between ages in terms of pollution, and his contribution to improving air quality would be high.

- The profession [professionZ]; it is a qualitative variable that describes the socio-professional categories of respondents. It takes the value 1 when the individual is a motorcycle-taxi driver and the value 0 otherwise. Motorcycle-taxi drivers may be more willing to contribute because of the diseases to which they are exposed.

- The education level [nivetude] is a qualitative variable. It has four modalities [primary, secondary, higher, none]. The more the individual is educated, the more he would contribute to the improvement of air quality. Before inserting this variable in the econometric model, each modality has been dichotomized.

- The monthly income of the respondent [tranchrev]; it is a continuous quantitative variable. Incomes are grouped by income bracket. We have identified nine income brackets: 1-Less than FCFA 30.000; 2-FCFA 30,001-40.000; 3-FCFA 40,001-50.000; 4-FCFA 50,001-60,000; 5-FCFA 60,001-70,000; 6-FCFA 70,001-80,000; 7-FCFA 80,001-90.000; 8-FCFA 90,001-10.0000, 9-More than FCFA 100,000. The higher the income of the individual, the more he would be willing to contribute.

- The respondent's smoking status [fumeur] is a dichotomous qualitative variable that takes the value 1 if the individual smokes cigarettes and 0 otherwise. Given that a smoker is used to living in cigarette smoke, pollution in general may no longer seem worrisome to him and from this point of view, he will have a lower willingness to pay.

- Respondent's relocation status [projdemenagpoll] is a dichotomous variable that takes the value 1 when the individual intends to relocate due to air pollution and 0 otherwise. When an individual has such a plan, he will have a low contribution to improving air quality because of his investment in relocation.

- The variable [airpollue] reflects whether the individual recognizes that the air is polluted in the city of Cotonou. It is dichotomous and takes the value 1 when the individual recognizes that the air is polluted in Cotonou and 0 otherwise. Its effect on the willingness to pay is positive.

Table 1 presents the different expected effects of the explanatory variables on the dependent variable (monthly willingness to pay: capmois). Indeterminate effects assume that it is not easy to make a prediction on the effects of the different variables involved on the variable "capmois".

Estimation model of the psychological cost of morbidity

In view of the above, the dependent variable WTP reflecting the individuals' willingness to pay contains valid zeros. Its values are in the range [0; 6,000]. The values of this interval of the dependent variable are greater than or equal to zero. It is possible to use a censored Tobit model. This model is used when in a situation where the dependent variable is zero for a significant number of observations [25]. The use of a censored Tobit model to explain the individuals' WTP is justified. For some authors [26], the choice of the econometric model depends on the assumption made in the process for revealing the WTP. Thus, according to them, the two-step procedure of Heckman [27] can be used.

Based on the contingent scenario presented to respondents, the decision process is sequential; this leads us to estimate the two-step model of Heckman [27] or the generalized Tobit.

Presentation of the generalized Tobit model: In the scenario presented to heads of household, the choice of the WTP is made in two steps. First he chooses either case 2 or case 1, which indicates whether or not he is ready to participate; then he chooses the desired amount in the event that he decides to participate. In this process, the decision is sequential. So, formalizing this situation might look as follows:

In the first step the individual is faced with a choice situation that can be reflected by a dichotomous model based on a latent variable y_i^*.

$$\begin{cases} if\ y_i^* > 0 \text{ the individual } i \text{ chooses case2 (decides to participate)} \\ if\ y_i^* \le 0 \text{ the individual } i \text{ chooses case1 (decides not to participate)} \end{cases}$$

In the second step, if the individual chooses case 2, he also chooses his WTP. Here we have a censored data model, defined by $\forall i = \overline{1,n}$:

$$CAP_i = \begin{cases} CAP_i^* & if\ y_i^* > 0 \\ 0 & if\ y_i^* \le 0 \end{cases} \qquad [M\ 1]$$

For Greene [26] 7 (taken over by N'Guessan [25]), the quality of estimators from the generalized Tobit depends on how the explanatory variables are introduced in explaining y_i and the WTP. It is important not to include exactly the same explanatory variables in both equations. Thus, we have:

$$\begin{aligned} y_i^* &= X_1\beta_1 + \varepsilon_{1i} \\ CAP_i^* &= X_2\beta_2 + \varepsilon_{2i} \end{aligned} \qquad [M\ 2]$$

With X_1 and X_2 designating the explanatory variables [socioeconomic or demographic characteristics]; β_1 and β_2 are parameters to be estimated, and ε_j (j=1,2) are the error terms that follow a bivariate normal distribution with ρ as correlation coefficient. After normalization [σ_1=1] we have:

$$\begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \end{pmatrix} \rightarrow N\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \Omega\right); \quad \Omega = \begin{pmatrix} 1 & \rho\sigma_2 \\ \rho\sigma_2 & \sigma_2^2 \end{pmatrix}$$

For reasons of simplification, a dichotomous variable D_{2i} is inserted so that we have:

$$D_{2i} = \begin{cases} 1 & if\ y_i^* > 0 \\ 0 & if\ y_i^* \le 0 \end{cases} \qquad [M\ 3]$$

So the estimation of the model can be made using the two-step method of Heckman [27] or the full-information maximum likelihood method.

Variables	Expected effects
Sex	**Indeterminate**
Age	+
Professions	+
Tempshabit	+
Settle	+
Nivetude	+
Smoking	-
projdemenagpoll	-
Air pollution	+

Source: Author

Table 1: Explanatory variables and expected effects.

Variables	Coefficients	P >|z|
Settle	0.1082956***	0.000
Age	-0.017604**	0.019
Tempshabit	-0.00206	0.715
Air pollution	0.6719894*	0.085
Professions	0.2145211	0.180
Number of observations=584 LR chi2(5)=32.14 Probability>chi2=0.0000		

***significant at the 1% threshold; **significant at the 5% threshold; *significant at the 10% threshold

Source: Extract from estimation results.

Table 2: Determining variables of the participation model.

Variables	Coefficients	P >|z|
Settle	71.88752*	0.084
age	37.24831	0.207
AGE CAR	-0.3148363	0.364
smoking	320.2954**	0.042
sex	-274.5266**	0.043
projdemenagpoll	181.7703*	0.082
professions	-75.0474	0.598
niv2	-39.57184	0.747
niv3	850.3739***	0.000
niv4	-8.04537	0.962
lambda	-1516.674	0.214
Number of observations=516 F(11,504)=11.41 Probability>F=0.0000		

***Significant at the 1% threshold; **significant at the 5% threshold; *significant at the 10% threshold

Source: Extract from estimation results

Table 3: Determining variables of the WTP.

Results and Discussions

Determinants of participation in the improvement of air quality

The estimation of the participation model [M 3] gives the results presented in Table 2.

From the analysis of Table 2, it appears that the determining variables of participation in the program are: income, age and quality of air. Income is significant at the 1% threshold while age and quality of air are respectively significant at the 5% and 10% thresholds. Thus, when the individual's income increases, his probability of participating in the air quality improvement program becomes greater. Similarly, the fact that the individual recognizes that the air is polluted increases his probability of participating in the air quality improvement program.

Determinants of the monthly WTP

The second step of the estimation gives the results for model [M2] and presents the various determinants of the monthly willingness to pay (Table 3). According to the results of this table, five variables are significant. The variable “tranchrev” is significant at the 10% threshold. Its effect is positive and was expected. Thus, the willingness to pay depends positively on the income, confirming the economic theory that the willingness to pay of an individual increases with his income.

The fact that the individual is a smoker affects positively the willingness to pay. This effect was not expected. This significance at the 5% threshold of the variable "fumeur" suggests that the smoking individual knows the severity of the pollution from cigarette smoke on health. For this reason, he seems to be willing to participate in the air quality improvement program.

The negative significance at the 5% threshold of the variable "sexe" shows that males are less willing to participate than women. This could be justified by the fact that a woman would be more sensitive to the health effects of air pollution that a man. The variable "projdemenagpoll" is positively significant at the 10% threshold, which was not expected. This positive effect means that the individual who intends to relocate is more willing to participate than the one who does not. Thus, the awareness that leads the individual to undertake to relocate because of air pollution causes him to support an air quality improvement project. The education level is significant. Precisely, the effect for an individual of a higher level is positively significant at the 1% threshold compared to an individual having a primary level. In other words, a person of a higher education level is more willing to participate than a person having a primary level.

The variable "lambda" is the inverse Mills ratio. This variable is not significant, which reflects the absence of selection bias. The mean WTP predicted from the model is about FCFA 1,360. But taking into account the individuals' average predicted probability of contributing financially, the average monthly WTP is about FCFA 1,200. Thus, the annual contribution of an individual to fight against air pollution in order to reduce the discomfort due to morbidity, is about FCFA 1,200 × 12=FCFA 14,400, all else being equal.

Ultimately, the determining variables of the individuals' willingness to pay are identified and the psychological cost or cost of suffering associated with the disease, is derived and is about FCFA 1,200/month per household head. So for individuals to reduce their risk of suffering from the ills they have referred to, they are ready to contribute for FCFA 1,200/month so that the air pollution is reduced by half. This amount represents the average cost of discomfort due to diseases related to air pollution. This assumes that the annual contribution of the population to a program against air pollution is FCFA 14,400 per individual. By comparing the annual cost of discomfort obtained in this work to the one obtained by Rozan [9], we note that the result of this author (F 282 or FCFA 28,200) is FCFA 13,800 greater than that of this work. This may be justified by the fact that the conditions in which the different studies were conducted are not identical in every respect. In addition, the levels of income are not the same in these different studies. Taking into account other works, the amount obtained in our work is not exaggerated. For example Gerking and Stanley [12] calculated the WTP for a given reduction in pollution and they obtained an average annual WTP between $ 18.45 and $ 24.48 (between FCFA 10,148 and FCFA 13,464). The fact that those amounts are relatively lower compared to that of this work and the one of Rozan, may be explained for example by the reduction percentage (30%) of the average ozone concentrations suggested by the study of Gerking and Stanley, as well as by the specificities of the study environments. Ultimately, the amount of the psychological cost of morbidity considered is FCFA 1,200 per month per morbidity episode.

Conclusion

In this article, the psychological cost of morbidity due to air pollution in the city of Cotonou is assessed. This assessment is made using a contingent valuation approach. Although precaution is taken in preparing the contingent valuation questionnaire, some biases may exist given that the population's level of understanding is not uniform. But the expertise of the different experts on field surveys that have contributed to the development of the questionnaire has reduced a number of biases, enabling the validity of the results. Thus, a head of household of Cotonou city falling ill due to air pollution bears an average psychological cost of FCFA 1,200 per month. This result is one of the few assessments of this kind in Benin or even in West Africa. On this basis, public decisions could be taken in order to internalize the effects of air pollution on morbidity.

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