

# Effects of Charcoal Marketing on the Environment and Health in the City of Cotonou in Southern Benin

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## Abstract

Charcoal marketing is the main activity in the Gbgamey district of Cotonou. The aim of the study was to determine the effects of charcoal marketing on the environment and health of the Gbgamey population. A mixed descriptive and evaluative design was adopted. Data were collected using an interview guide, a structured non-participatory observation grid and air quality analysis equipment (PCE RCM 8 air quality detector; Carbon monoxide meter AS 87000A and Anemometer AM 4812) among charcoal traders, food vendors and residents living near charcoal sales outlets, selected by non-probabilistic purposive sampling, and were analysed with reference to national regulatory provisions and WHO recommendations (2022). 57 people, including 26 shopkeepers, were surveyed. Their average age was 45, with extremes of 25 and 65. The effects of charcoal marketing on health and the environment were known to 23 traders, who unfortunately did not adopt any protective measures. Some of the health effects mentioned were rheumatic and cardiovascular diseases. Pollutants ( $PM_{10}$ : 96  $\mu\text{g}/\text{m}^3$ ,  $PM_{2.5}$ : 161  $\mu\text{g}/\text{m}^3$ ,  $PM_{10}$ : 206  $\mu\text{g}/\text{m}^3$ , CO: 185  $\text{mg}/\text{m}^3$ ) were present in the coal-selling environment at Gbgamey. According to the respondents, respiratory diseases (42.31%), rheumatic diseases (30.77%) and cardiovascular diseases (11.54%) affected the traders, while respiratory diseases (51.61%) affected the general population. The marketing of charcoal in the Gbgamey district generates a high concentration of pollutants in the atmosphere. The activity needs to be monitored in order to limit its effects.

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## Keywords

Marketing, Charcoal, Effects, Health, Environment

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### 1. Introduction

Charcoal is a fuel obtained by carbonising wood in the absence of oxygen (Mbola Mukas & Ntambwe Mukalamusi, 2021; Arnold & Jongma, 1978; Pelletier-Bergeron, 2013). Despite the advent of other energy sources such as gas, charcoal is still widely used. Worldwide, 47041814 tonnes of charcoal are produced every year (Jan, Gilles, & Grégory, 2018), and more than 2.4 billion people—around a third of the world's population—still rely on wood fuels for cooking (Ahissan, Gbocho, & Atta, 2022; Bellefontaine, Petit, Bertault, Deleporte, & Pain-Orcet, 2001). In Africa, wood is a widely used source of energy for heating and cooking, and is a basic necessity. The main source of domestic energy in Africa, 80% of households in Benin use coal, even though it is a source of pollution and a cause of deforestation (Darate, 2023). Coal accounts for 69% of the energy used in Africa (Traore, 2024).

The high use of this fuel by the population has led many men and women to become involved in the charcoal trade in Africa in general, and in Benin in particular. However, despite being a source of income for many households, the marketing of this fuel poses risks both to people's health and to the environment (Coulibaly & Pohor, 2016).

The Gbgamey district of Cotonou is a hotbed of charcoal trading. The alleyway running alongside the rails in Gbgamey, the main hub for charcoal sales, is covered in charcoal residue and dust, making the air and soil polluted. The owners of the restaurants and maquis set up along this route cook and sell their meals in this environment, which compromises the food hygiene quality of the meals sold. Charcoal merchants, exposed all day long to the dust from the charcoal, bend over for long hours to sort the coals and put the pieces of charcoal into various packs. This exposes them to numerous health problems associated with their work.

The aim of this research is to assess the effects of charcoal marketing on the environment and the health problems encountered by the population.

### 2. Materials and Methods

The study was conducted in the Gbgamey district, in the eleventh arrondissement of Cotonou, Benin. It was a descriptive cross-sectional study that took place from 03 to 23 June 2023. The targets were charcoal traders (primary) and sellers of other items, as well as households located near charcoal sales points (secondary). The inclusion criteria were: to be a charcoal trader in Gbgamey; a seller of other items located or living near charcoal sales points; to have given their consent to participate in the study; and to be present during the study period. Anyone who was unable to complete the study was excluded. Non-probability, purposive

sampling was used. Data were collected using an interview guide, a structured non-participatory observation grid and air quality analysis equipment (PCE RCM 8 air quality detector, AS 87000A carbon monoxide meter and AM 4812 anemometer) in accordance with national regulations and WHO recommendations (2022). Data collection was carried out using Kobo Collect software for questionnaire surveys. Excel version 2019 was used for data analysis, tables and graphs, and Microsoft Word version 2013 for data entry. Authorisation for data collection was obtained from the head of the Gbgamey neighbourhood. The anonymity and confidentiality of the information collected were respected.

### 3. Results

#### 3.1. Description of the Sample

A total of 57 subjects were surveyed: 26 female charcoal traders and 31 female food vendors and residents living near charcoal sales outlets.

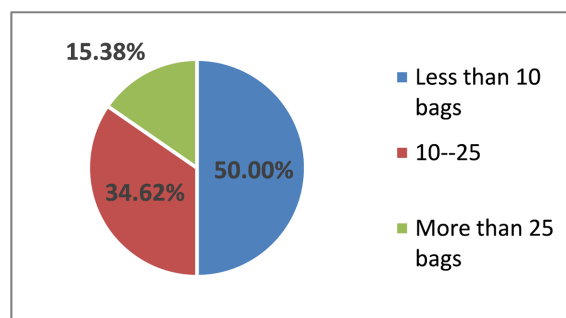
The majority of respondents were women (76.92%) and the most common age group was 45 to 65 (38.46%). The majority of respondents (38.46%) had no formal education, and 53.85% had been selling charcoal for more than 10 years.

In addition to the charcoal sellers, the sample also included 31 meal sellers and residents living near the charcoal sales points in Gbgamey. The majority of these vendors and residents were women (58.06%). The age group most represented among the vendors of meals and residents was between 30 and 59 (54.84%).

More than half of those surveyed (64.52%) had been working in the Gbgamey neighbourhood for more than 10 years.

#### 3.2. Distribution of Charcoal Traders in Gbgamey According to the Number of Bags of Charcoal Sold per Day in 2023

Half the traders sell fewer than ten bags of charcoal a day, as shown in **Figure 1**.



**Source:** Field survey data, June 2023.

**Figure 1.** Distribution of charcoal traders in Gbgamey by number of bags of charcoal sold per day in 2023 (n = 26).

#### 3.3. Distribution of Charcoal Traders in Gbgamey by Form of Sale and Availability of Charcoal Storage Facilities in 2023

More than half of charcoal sellers pack charcoal in bags, but around 89% of them

do not have a storage warehouse, as shown in **Table 1**.

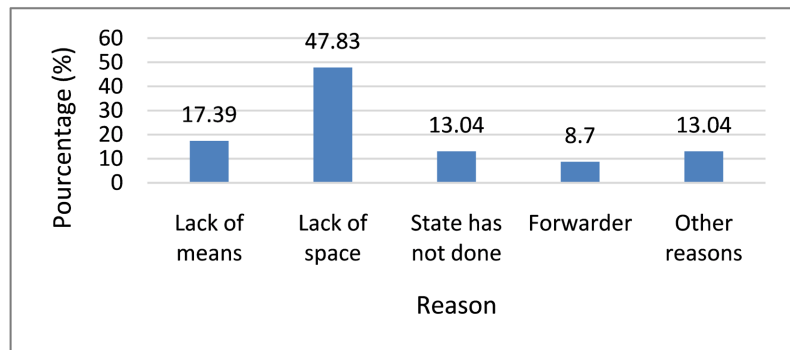
**Table 1.** Distribution of charcoal traders in Gbgamey by form of sale and availability of charcoal storage facilities in 2023 (n = 26).

Variables	Frequencies	%
<b>Form of sale applied</b>		
Per kg/Per bag	14	53.84
Par truck	3	11.54
Per bag	8	30.77
Per truck/Per bag/Per kg	1	3.85
<b>Availability of storage facilities</b>		
No	23	88.46
Yes	3	11.54
<b>Location of shops</b>		
Near to market	1	33.33
Gbgamey	1	33.33
Gbgamey rented premises	1	33.33

**Source:** Field survey data, June 2023.

### 3.4. Distribution of Charcoal Traders in Gbgamey According to Reasons for Non-Availability of Storage Facilities in 2023

Around half (47.83%) of charcoal sellers cite lack of space as the reason for the non-availability of a storage warehouse, as shown in **Figure 2**.



**Source:** Field survey data, June 2023.

**Figure 2.** Distribution of charcoal traders in Gbgamey according to reasons for non-availability of storage facilities in 2023 (n = 23).

### 3.5. Knowledge of Charcoal Traders and Inhabitants of Gbgamey about the Effects of Charcoal Marketing on the Environment and Their Health in 2023

As shown in **Table 2**, most (88.46%) charcoal sellers are aware of the risks associated with their trade, but very few (26.92%) adopt protective measures.

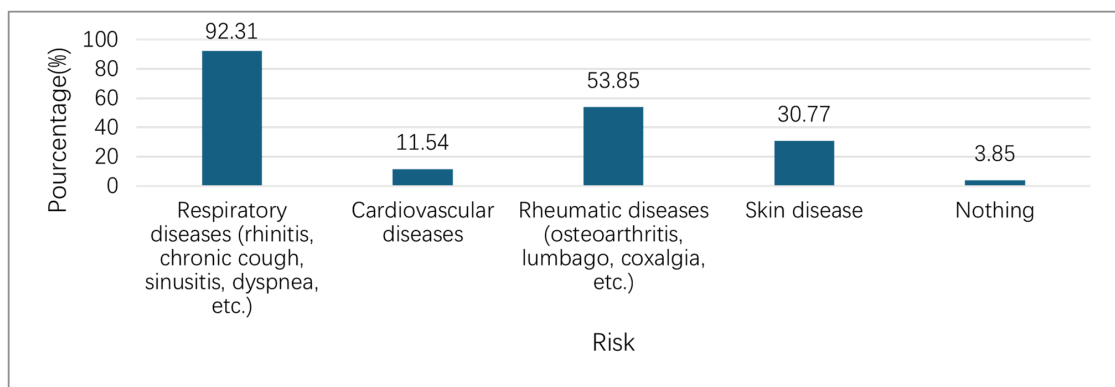
**Table 2.** Distribution of charcoal traders in Gbegamey according to their knowledge of the effects of charcoal marketing and the adoption of risk prevention measures in 2023 (n = 26).

Variables	Frequencies	%
<b>Knowledge of the effects of marketing charcoal on your health and the environment</b>		
No	3	11.54
Yes	<b>23</b>	<b>88.46</b>
<b>Adoption of individual or collective protection</b>		
No	<b>19</b>	<b>73.08</b>
Yes	7	26.92
<b>Protection used (n = 7)</b>		
Nose plug	3	42.86
Milk peak	3	42.86
Others	1	14.29
<b>Reason for not using protection (n = 19)</b>		
Poverty	<b>8</b>	<b>42.11</b>
Difficulty breathing with nose plugs	3	15.79
Not necessary	6	31.58
Lack of knowledge about protection	1	5.26
<b>informed of the risks associated with the coal trade</b>		
No	<b>21</b>	<b>80.77</b>
Yes	5	19.23

Source: Field survey data, June 2023.

### 3.6. Distribution of Charcoal Traders in Gbegamey According to Their Knowledge of the Health Risks Associated with the Marketing of Charcoal in 2023

Respiratory, rheumatic and skin diseases are the main health risks associated with the charcoal trade cited by sellers, as shown in **Figure 3**.

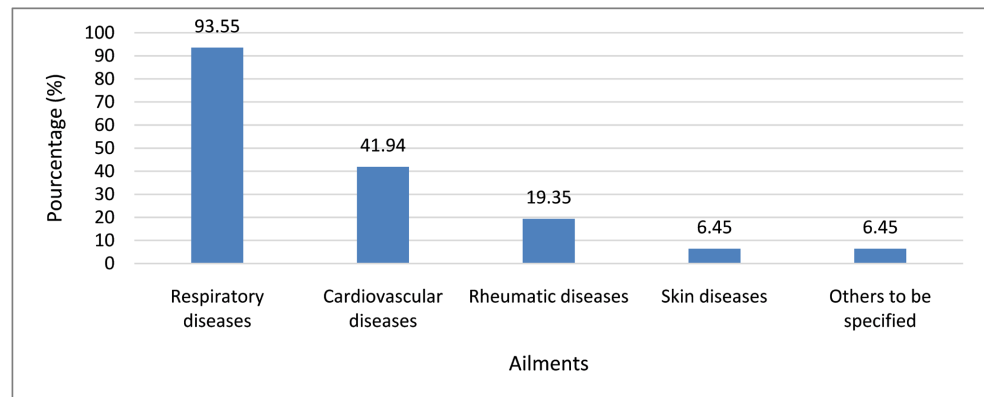


Source: Field survey data, June 2023.

**Figure 3.** Distribution of charcoal traders in Gbegamey according to their knowledge of the health risks associated with charcoal marketing in 2023 (n = 23).

### 3.7. Distribution of Gbgamey Residents According to Their Knowledge of the Health Risks Associated with Charcoal Marketing in 2023

According to the inhabitants of the Gbgamey district, respiratory, cardiovascular and rheumatic diseases are the most common predisposing factors associated with the charcoal trade, as shown in **Figure 4**.

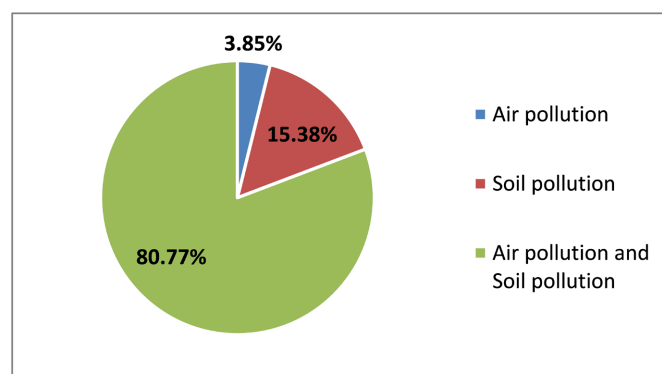


Source: Field survey data, June 2023.

**Figure 4.** Distribution of Gbgamey residents according to their knowledge of health problems associated with charcoal marketing in 2023 (n = 31).

### 3.8. Gbgamey Charcoal Traders' Knowledge of the Environmental Risks Associated with Charcoal Marketing in 2023

Charcoal merchants believe that their activities cause air and soil pollution, as shown in **Figure 5**.

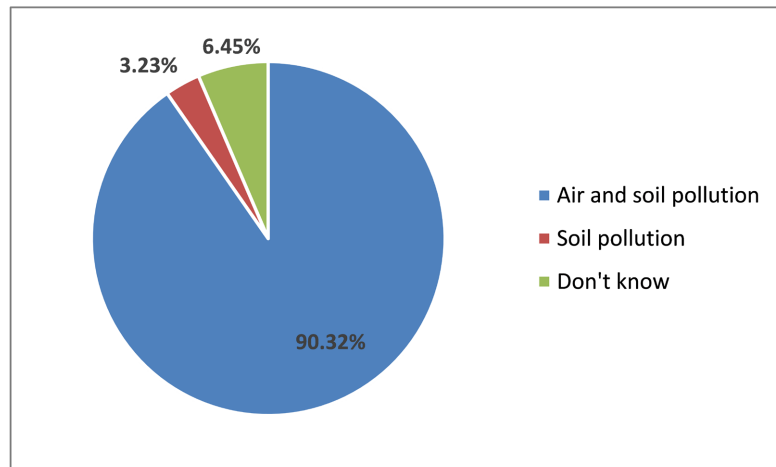


Source: Field survey data, June 2023.

**Figure 5.** Distribution of charcoal traders in Gbgamey according to their knowledge of the environmental risks associated with charcoal marketing in 2023 (n = 26).

### 3.9. Gbgamey Residents' Knowledge of the Environmental Risks Associated with Charcoal Marketing in 2023

The residents of Gbgamey have knowledge of environmental pollution linked to the charcoal trade, as shown in **Figure 6**.



Source: Field survey data, June 2023.

Figure 6. Distribution of residents according to their knowledge of the environmental risks associated with charcoal marketing (n = 26).

### 3.10. Occupational and Environmental Risks Associated with Charcoal Marketing in Gbegamey in 2023

Charcoal merchants work more than 10 hours a day (73.08%) and adopt a variety of positions, lifting heavy loads (53.85%), as shown in Table 3.

Table 3. Distribution of charcoal traders in Gbegamey by length of daily working hours, position adopted at work and effects on health in 2023 (n = 26).

Variables	Frequencies	%
<b>Working hours per day</b>		
Less than 10 hours	7	26.92
More than 10 hours	19	73.08
<b>Position most often adopted during work</b>		
Sitting	6	23.08
Bent over	6	23.08
Standing	1	3.85
Sitting/Curved	2	7.69
Sitting/Stooping/Standing	11	42.31
<b>Lifting heavy loads</b>		
No	12	46.15
Yes	14	53.85
<b>Feeling unwell at the end of the day</b>		
No	1	3.85
Yes	25	96.15
<b>Carrying an illness requiring regular medical check-ups</b>		
No	19	73.08
Yes	7	26.92

Continued

<b>Suffering from a skin disease in recent years</b>		
No	22	84.62
Yes	4	15.38
<b>Wish to change activity</b>		
No	8	30.77
Yes	18	69.23
<b>Reason for wanting to change activity (n = 18)</b>		
Difficult job	1	5.56
Poor performance	5	27.78
Activity causes health problems	7	38.89
Tiring	5	27.78

Source: Field survey data, June 2023.

Most Gbgamey residents have never traded charcoal (87.10%), use it daily (70.97%) and have found that the air has become impure as a result (93.55%), as shown in **Table 4**.

**Table 4.** Distribution of the inhabitants of Gbgamey according to the frequency of use of charcoal at home and the effects of the marketing of charcoal on their health in 2023 (n = 31).

Variables	Frequencies	%
<b>Previous marketing of charcoal</b>		
No	27	87.10
Yes	4	12.90
<b>Frequency of use of charcoal at home</b>		
Several times a week	4	12.90
A few times a month	2	6.45
Daily	22	70.97
Rarely	3	9.68
<b>Change in air quality</b>		
No	2	6.45
Yes	29	93.55
<b>Suffered from a respiratory ailment</b>		
Non	15	48.39
Oui	16	51.61
<b>Type of respiratory ailment identified (n = 16)</b>		
Rhinitis	7	22.58
Cough	6	19.35
Asthma/Bronchitis	3	9.68
<b>Skin conditions identified</b>		
No	27	87.10
Yes	4	12.90

Source: Field survey data, June 2023.

### 3.11. Observation of Gbgamey Charcoal Traders in Their Sales Environment in 2023 (n = 10)

Uncovered food is exposed for sale, in an environment made unsanitary by charcoal debris, as shown in **Table 5**.

**Table 5.** Results of observation of Gbgamey charcoal traders in their sales environment (n = 10).

Variables	Frequencies	%
<b>Environmental health status</b>		
Unhealthy	10	100
<b>Existence of a shop</b>		
No	10	100
<b>Use of personal protective equipment</b>		
No	2	20.00
Yes	8	80.00
<b>Type of protection (n = 8)</b>		
Headgear	5	50.00
Apron	3	30.00
Bib	0	0.00
<b>Posture of coal traders</b>		
Sitting	5	50.00
Bent	5	50.00

**Source:** Field survey data, June 2023.

All of the traders observed work in an unhealthy environment polluted mainly by charcoal debris and dust. None of them had shops for storing bags of charcoal.

The majority of traders (80%) use protective equipment, consisting mainly of a cap (50%) and an apron (30%). Half of the traders (50%) were seated and the other half bent over during the observation.

Food is displayed for sale, uncovered, and made unsanitary by charcoal debris in this environment, as reported in **Table 6**.

**Table 6.** Observation results for women selling meals in Gbgamey near charcoal sales points in 2023 (n = 12).

Variables	Frequencies	%
<b>Environmental health status</b>		
Unhealthy	6	50.00
Sanitary	6	50.00
<b>Absence of charcoal waste at meal sales points</b>		
No	9	75.00
Yes	3	25.00
<b>Presence of protective covers for meals</b>		
No	5	41.67
Yes	7	58.33

**Source:** Field survey data, June 2023.

Half of the food vendors in the charcoal sales environment observed sell in an unhealthy environment and 58.33% of vendors are located very close to charcoal traders. The majority of the food vendors observed (58.33%) protect their food with a blanket, while 41.67% do not protect their food.

### 3.12. Air Quality at the Charcoal Sales Site in Gbgamey in 2023

Particulate air pollution is present at the charcoal marketing site in Gbgamey, as shown in **Table 7**.

**Table 7.** Air quality in the charcoal marketing environment along the rails at Gbgamey.

Geographics coordinates	Site	Current activities	Time	T °C	H: %	Particle concentration $\mu\text{g}/\text{m}^3$			TVOC $\text{mg}/\text{m}^3$	HCHO $\text{mg}/\text{m}^3$	V/air: m/s		Other polluting gases ppm		Observations
						PM <sub>1.0</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>			MIN	MAX	CO	CO <sub>2</sub>	
6°21'43"N 2°24'29"E	Start of the charcoal market	No activity	3.23 PM	33.3	79	10	15	18	0.009	0.009	0.5	1.6	0.00	420	Nothing to report
6°21'44"N 2°24'28"E	Inside the charcoal market	No activity	3.26 PM	32.8	82	7	13	16	0.013	0.009	0.8	1.8	0.00	414	Nothing to report
6°21'45"N 2°24'27"E	Inside the charcoal market	Handling charcoal	3.30 PM	32.6	83	7	13	17	0.101	0.009	0.00	0.4	0.00	402	Coal bagging
6°21'45"N 2°24'27"E	Inside the charcoal market	Handling charcoal	3.34 PM	31.4	87	96	161	206	0.068	0.009	0.5	2.6	185	404	Sample affected by smoke from a lady's fire
6°21'46"N 2°23'24"E	Inside the charcoal market	Cooking food	3.40 PM	30.9	88	40	65	84	0.191	0.009	0.4	0.8	22	412	Cooking food that generates enough smoke
6°21'47"N 2°24'25"E	End of the charcoal market	No activity	3.45 PM	31.2	84	7	14	19	0.027	0.009	0.9	2.4	0.00	405	Nothing to report

**Legend:** high value. **Source:** Field survey data, June 10, 2023.

## 4. Discussion

Analysis of the results shows that in the Gbgamey district of Cotonou, the majority of traders (38.46%) sell charcoal by the kilo and by the sack. Half of the traders surveyed (50%) sell less than 10 bags of charcoal per day. 88.46% of traders do not have storage facilities. Lack of space is the main reason why most charcoal traders in Gbgamey do not have storage facilities.

The environment in which charcoal is sold in Gbgamey contains a number of particles, in particular fine particles PM<sub>1.0</sub>, PM<sub>2.5</sub>, PM<sub>10</sub>; CO, CO<sub>2</sub>, and volatile organic compounds, which are pollutants.

The concentration of these particles is high inside the market due to charcoal

handling activities, and this is intensified when charcoal is burnt in the surrounding area for cooking meals. However, outside the market, where no charcoal is sold, air quality is good.

Analysis of the results of the data collection showed that 88.46% of the traders surveyed were aware of the effects of charcoal sales on their health and the environment. The majority mentioned the risk of contracting respiratory diseases and air and soil pollution. However, most of them (73.08%) do not use preventive measures due to a lack of financial resources (42.11%), and the minority who do use preventive measures just use muffs, which is not enough. 80.77% of them said they had not been made aware of the risks associated with their activity. As a result, charcoal traders in Gbgamey are aware of the effects of charcoal marketing on health and the environment, but lack knowledge and training on how to prevent the risks associated with this activity in order to protect their health and ensure their safety at work.

To identify the occupational hazards associated with charcoal marketing in Gbgamey, working conditions were first explored on the basis of certain aspects such as: workload, the hourly workload of each trader and the position most often adopted during the working day. The majority of respondents have an excessive hourly mass, lift heavy loads during their working day, and alternate between sitting, bending and standing during working hours. There is therefore a probable relationship between the various elements thus studied, and the discomfort (headaches, asthenia, muscle soreness...) felt by the majority (96.15%) at the end of the working day. The data collected show that charcoal traders in Gbgamey are affected by three main classes of charcoal-related illnesses: respiratory illnesses (42.31%), rheumatic illnesses (30.77%) and cardiovascular illnesses (11.54%). The population is more affected by respiratory illnesses (51.61%). This higher proportion of the population affected by respiratory diseases could be explained by the amplification of air pollution by fumes from the burning of charcoal when cooking meals.

The results of the air sampling confirmed the findings made earlier. In fact, air quality analyses showed high concentrations of fine particles  $PM_{1.0}$ ,  $PM_{2.5}$ ,  $PM_{10}$  in places where shopkeepers were packaging their charcoal, and these concentrations, combined with those of volatile organic compounds and carbon monoxide, increased in places where charcoal-burning meals were sold. These particles are notoriously toxic.  $PM_{1.0}$ ,  $PM_{2.5}$ ,  $PM_{10}$  particles affect the central nervous system and reproduction, and cause or aggravate cardiovascular and pulmonary diseases, heart attacks, cancer and premature death. As for their effects on the environment, these particles affect ecosystems, animals and plant growth. Carbon monoxide leads to heart disease, damages the nervous system and causes headaches, fatigue and dizziness (Cachon, 2013).

This explains the various illnesses reported among residents living near charcoal sales points and charcoal traders, as well as the headaches and fatigue experienced by these traders at the end of the working day.

The majority of merchants (69.23%) would like to change their activity if they

find another that is less arduous and more profitable than this one, due to the multiple effects on their health, while 30.77% have no plans to give it up, at the risk of becoming unemployed. These traders stress that, despite the effects on their health, charcoal marketing is very profitable. Charcoal is used daily by the population, so there is no shortage.

The results of the study reveal a good level of knowledge among traders of the effects of charcoal marketing on health and the environment, as well as a lack of knowledge and training on how to prevent the risks associated with their activity. This finding is similar to that of Akmel M. S., who, at the end of his study on “charcoal exploitation and health risks in ODJRUKE country”, reported that charcoal merchants are aware of the health risks and work-related accidents generated by their activity (AkmeI, 2012).

With regard to the risks associated with charcoal marketing on the health of the population and the environment, our results show that charcoal traders in Gbe-gamey are exposed to several illnesses, notably: respiratory, rheumatic and cardiovascular diseases, and charcoal marketing generates air and soil pollution. This is justified by the excessive hourly workload, the heavy loads lifted by traders during their working days, and the high concentration of pollutants in the air generated by the charcoal activity. These results concur with those of Akmel M. S., who reported joint and lung diseases among ODJRUKE coal miners (AkmeI, 2012).

## 5. Conclusion

This study explored the effects of charcoal marketing on the environment and the health of the population. Charcoal traders and residents living near charcoal sales outlets are exposed to charcoal dust that can cause respiratory, rheumatic and cardiovascular diseases. In addition, charcoal marketing generates environmental pollution from pollutants, notably PM<sub>2.5</sub> fine particles, TVOC and CO. The charcoal trade must be regulated and carried out away from dwellings and in a fairly well-ventilated environment, to protect the health of both traders and the population. The best thing is to develop improved cookstoves and alternative fuels in order to reduce the use of charcoal.

## Study Limitations

Notwithstanding the fact that our study covered only part of the population of Gbe-gamey, and that the sample size was small, the quality of the information provided by the participants enabled us to identify the effects of charcoal marketing in Gbe-gamey on the environment and the health of the population. In addition, analysis of the samples provided information on air quality in Gbe-gamey. The study's limitations lie in the fact that the air quality analysis was carried out during the rainy season, which could influence the results.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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