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### RESEARCH ARTICLE

#### INFLUENCE OF EXPOSURE TO DOUBTFUL QUALITY PETROL ON SINUS, LUNG AND HEART CONDITIONS IN VENDORS

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#### Abstract

The gaseous particles of doubtful quality petrol diffuse into the atmosphere and enter the body mainly via the respiratory tract, but its effects on the organs of the respiratory system are hardly understood. The aim of the study was to assess the influence of exposure to doubtful quality petrol on the condition of users' sinuses, lungs and heart. The sinuses, lungs and hearts of 80 sellers and 80 consumers of doubtful quality petrol were examined by X-ray. The frequencies of the anomalies recorded were calculated, and Chi<sup>2</sup> and Z tests were used to compare them among sellers and consumers, and according to the age classes of the respondents. Sinus abnormalities were more frequent (p<0.05) among sellers than the consumers. Maxillary sinus transparency decreased more (p<0.01) among sellers than the consumers. The proportion of sellers with opacity and decreased transparency in the frontal sinuses was significantly higher (p<0.05) than the ones of the consumers. Lung abnormalities included thoracic aorta unwinding, basal interstitial syndrome, localized mammary calcification, costo-diaphragmatic cul-de-sac blunting and bilateral bronchopathy. Among these abnormalities, bilateral bronchopathy was more common (p<0.05) among the sellers than the consumers. The proportion of vendors with a greater cardiothoracic index (CTI) more than 0.5 (42.5%) was significantly higher (p<0.001) than that of consumers (8.75%). Sinus damage varied very little from one age group to another. Sinus damage was reported more frequently (p<0.05) among the 20 to 30 years old sellers than among the same age group Consumers. Consumers aged between 20 and 30 showed fewer progressive pleuroparenchymal abnormalities than sellers in the same age group. The proportion of sellers aged 40 to 50 with an ICT greater than 0.50 is higher than that of consumers. The sale of doubtful quality

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petrol exposes the population to sinus, pulmonary and cardiovascular diseases.

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## **Introduction:-**

Large-scale illicit trafficking in petroleum products began in Benin in the 1980s and benefited from its proximity to Nigeria, Africa's leading producer (Eyebiyi, 2016). This activity helps families meet household needs (Montcho and Amouzouvi, 2015; Gbankoto et al., 2020a). Its rise is closely linked to the economic crises, when every citizen, faced with employment difficulties. Today, the sellers of doubtful quality petrols informal.

Doubtful quality petrol is sold on roadsides and streets, in villages and city districts all over the country (Gbankoto et al., 2020b). Despite its numerous advantages, doubtful quality petrol creates certain nuisances for the exposed population.

Work carried out by researchers on gasoline linked troubles on health has demonstrated respiratory effects such as throat irritation, runny nose, coughing, shortness of breath, disruption of lung function (Andrea and Reddy, 2014; Caruso et al., 2015; Alzahrani and Rajendran, 2019; Kuranchie et al., 2019) effects on the central nervous system, such as headaches, dizziness, tingling in the limbs, hot flushes and drowsiness (Sim et al., 2010; Andrea and Reddy, 2014; Alzahrani and Rajendran, 2019). Exposure to gasoline also causes skin irritation, dyspnoea and burning sensations in the eyes (Sim et al., 2010; Andrea and Reddy, 2014; Rashid et al., 2017).

In Benin, doubtful quality petrol is sold in bottles, sometimes without any cap, allowing the gas to escape, and is most often inhaled by the sellers during decanting. These sales conditions have prompted scientists to investigate the public health consequences of selling doubtful quality petrol. The work carried out by the latter consisted in listing the symptoms and ailments developed by gasoline sellers (Adeothy-Koumakpai et al., 2006; Gbankoto et al., 2020a,b). These studies have reported respiratory, nervous, digestive and cardiac symptoms. To better understand how these symptoms function a work was then carried out on the haematological and lipid profile of essence sellers. The results of these studies helped to explain conditions associated with haematological parameters such as fatigue and anaemia (Gbankoto, 2020). Investigations are also needed to better understand the link between gasoline sales and respiratory symptoms reported by vendors. The aim of this study is to assess the influence of exposure to doubtful quality gasoline on the sinus, lung and heart conditions of vendors.

## **Materials and Methods:-**

### **Scope of the study**

This work was carried out at the Centre Autonome de Radiologie de l'Ecole Polytechnique d'AbomeyCalavi of the University of Abomey-Calavi. This school is located in the Atlantic Department, AbomeyCalavi commune, Calavi center district.

### **Hardware**

The sinuses, lungs and hearts of vendors and consumers were examined by X-ray using a GE X-ray machine with an AGFA (Belgium) CR 30-Xm photostimulable screen digitizer and an AGFA DRYSTAR film printer.

## **Methodology:-**

### **Sampling**

An interview was first carried out with both exposed and unexposed subjects, and enabled us to exclude those whose family history was not favorable to the study. These included people with respiratory, cardiological or naso-sinus conditions prior to the sale or consumption of doubtful quality petrol. Smokers were also excluded from this part of the study. After this stage, 80 sellers and 80 consumers were randomly selected from those meeting the study criteria.

For each category (sellers and consumers), age classes were formed in order to assess the influence of age on the sellers' sinus, lung and heart conditions. In total, 5 age classes were formed: 15 to 20 years ( $\leq 20$  years), 21 to 30 years, 31 to 40 years, 41 to 50 years and 51 to 62 years ( $>50$  years).

### Sinus, Lung and Heart Examination

The influence of doubtful quality gasoline on the condition of the sinuses, lungs and heart was studied by means of X-ray examinations. Vendors and consumers identified for the study were invited to the Center for the examinations. This was followed by a telecoil and sinus X-ray at the Centre Autonome de Radiologie de l'Université d'Abomey-Calavi. The radiodiagnosis of the lesions consisted in X-raying the identified individuals by means of a telecoeur (frontal chest X-ray from a distance of two meters). This procedure was chosen because it not only allowed us to assess the lung area, but also to measure the cardiothoracic index (CTI). The Blondeau sinus angle was chosen because it allows visualization of almost all the sinuses of the face.

### Statistical analysis

Data were recorded in Excel and analyzed using SAS software (SAS Institute Inc., Cary, NC, USA). Observed frequencies were calculated using SAS's Proc FREQ procedure, and the Chi<sup>2</sup> test was used to determine the significance of the status effect and age effect on each abnormally observed. Relative frequencies were compared in pairs using the two-tailed Z-test. For each relative frequency, a 95% confidence interval (CI) was calculated using the formula:

$$CI = 1,96 \sqrt{\frac{P(1 - P)}{N}}$$

Where P is the relative frequency and N the sample size.

### Ethical considerations

Our study was approved by the Comité National d'Ethique pour la Recherche en Santé (CNERS), which validated the protocol at its session No. 39 on October 15, 2019. Voluntary and informed consent was obtained from both vendors and consumers prior to their participation in the study.

### Results:-

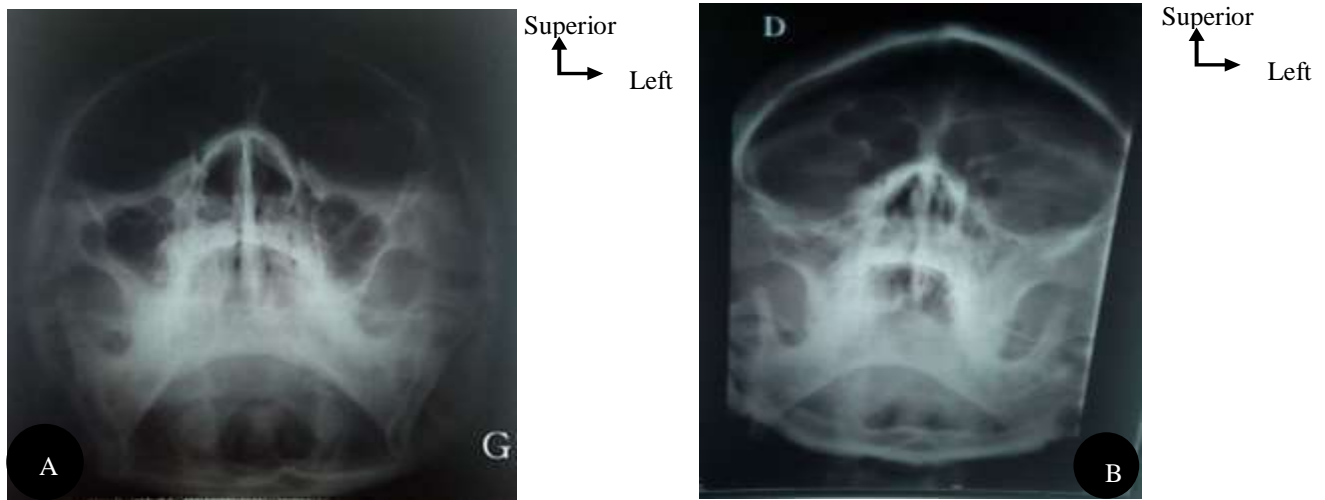
#### Influence of exposure to adulterated gasoline on sinus status

The frequency of sinuses with abnormalities was higher ( $p < 0.05$ ) in sellers (63.75%) than in consumers (46.25%). Similarly, consumers had more ( $p < 0.01$ ) normal maxillary and frontal sinuses than vendors (Table 1).

The abnormalities observed in the maxillary sinuses were opacity, decreased transparency and thickening in frames. Decreased transparency was observed more ( $p < 0.01$ ) in sellers (26.25%) than in consumers (10%). Opacity (Fig. 1B) was also observed more in sellers, and the observed frequency was significantly different from that of consumers.

The anomalies observed in the frontal sinuses were opacity, hypoplasia, agenesis, hypertrophy, hypogenesis and decreased transparency (table 1). The proportion of sellers with opacity (16.25%) and decreased transparency (4.8%) was significantly higher ( $p < 0.05$ ) than that of consumers, which was 6.5% and 0% respectively. The proportion of sellers with frontal sinus hypoplasia, agenesis and hypertrophy was not significantly different from that of consumers.

**Figure 1:-** Frontal and maxillary sinuses of petrol salesmen (A: Normal aeration, B: Near-total opacities in the left maxillary sinus and framed opacities in the right maxillary sinus).



**Table 1:-** Sinus attacks by sellers and consumers of adulterated petrol in southern Benin.

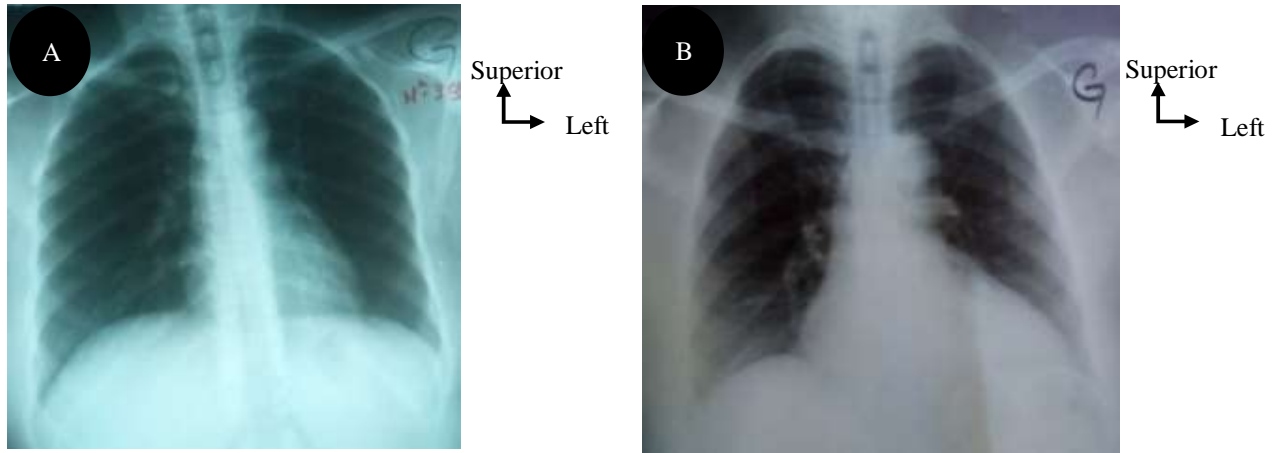
Variable	Consumer n=80		Vendor (n=80)		Chi <sup>2</sup>
	%	CI	%	CI	
<b>Sinus disease</b>					
Yes	46.25	10.9	63.75	10.5	*
No	53.75	10.9	36.25	10.5	*
<b>Damage to the maxillary sinuses</b>					
Normal ventilation	53.75	10.9	40	10.7	NS
Opacity	37.5	10.6	36.25	10.5	NS
Reduced transparency	10	6.6	26.25	9.6	**
Frame thickening	0	0	5	4.8	*
<b>Attacks on the frontal sinuses</b>					
Normal ventilation	75	9.5	58.75	10.8	*
Opacity	6.25	5.3	16.25	8.1	*
Hypoplasia	5	4.8	1.25	2.4	NS
Agenesis	6.25	5.3	1.25	2.4	NS
Hypotrophy	1.25	2.4	0	0	NS
Reduced transparency	0	0	5.13	4.8	*

CI: Confidence Interval, \*: p<0.05; \*\*: p<0.01; NS: Not Significant

**Influence of exposure to adulterated petrol on lung and heart condition**

In the case of lungs, 87.5% of sellers did not present a pleuroparenchymal abnormality, compared with 82.5% of consumers. However, the difference between these two frequencies was not significant (Table 2). The lung abnormalities observed were unwinding of the thoracic aorta, basal interstitial syndrome (Figure 2B), localized mammary calcification, blunting of the costo-diaphragmatic cul-de-sac and bilateral bronchopathy. Of these abnormalities, basal interstitial syndrome (3.75%) and bilateral bronchopathy (6.25%) were reported only in sellers.

Table 3 shows the influence of doubtful quality petrol on the cardiothoracic index (CTI). The proportion of consumers with a CTI below 0.5 (70%) was significantly higher (p<0.01) than that of sellers (51.25%). Conversely, the proportion of sellers with a TCI above 0.5 (42.5%) was significantly higher (p<0.001) than that of consumers (8.75%). The difference between the proportion of sellers and consumers with a TCI equal to 0.50 was not significant.



**Figure 2:-** Examination of the lungs (A: Normal cardiac silhouette and absence of progressive pleuroparenchymal lesion; B: Enlarged cardiac silhouette and right basal interstitial syndrome)

**Table 2:-** Influences of adulterated petrol on lung condition.

Variable	Consumer (n=80)		Vendor (n=81)		Chi <sup>2</sup>
	%	CI	%	CI	
No progressive pleuroparenchymal abnormalities	82,5	8,33	87,5	7,25	NS
Uncoiling the thoracicaorta	17,5	8,33	8,75	6,19	NS
Basal interstitial syndrome	0	0,00	3,75	4,16	NS
Localized breast calcification	1,25	2,43	2,5	3,42	NS
Blunt costo-diaphragmatic cul-de-sac	10	6,57	5	4,78	NS
Bilateral bronchial disease	0	0,00	6,25	5,30	*

CI: Confidence Interval, \*: p<0.05; NS: Not Significant

**Table 3:-** Influence of adulterated petrol on cardiothoracic index.

Variable	Consumer (n=80)		Vendor (n=80)		Chi <sup>2</sup>
	%	IC	%	IC	
ICT < 0,50	70	10,04	51,25	10,95	*
ICT = 0,50	12,5	7,25	6,25	5,30	NS
ICT > 0,50	8,75	6,19	42,5	10,83	***

CI: Confidence Interval, \*\*: p<0.01; \*\*\*: p<0.001; NS: Not Significant

**Influence of age on sinus and pulmonary anomalies and cardiothoracic index**

**Sinus disease**

Sinus damage varied very little from one class to another. Sellers between the ages of 40 and 50 have more sinus abnormalities overall (p<0.05) than consumers. Maxillary and frontal sinus anomalies were more common (p<0.05) among sellers aged between 20 and 30 than consumers in the same age group. However, the rates of the various abnormalities recorded in these sinuses did not vary significantly from one age group to another. The decrease in maxillary sinus transparency was, however, more marked (p<0.05) in sellers than in consumers from the age of 30 onwards (table 4).

**Pulmonary damage and cardiothoracic index**

Lung abnormalities varied very little from one age group to another. Consumers aged between 20 and 30 showed fewer progressive pleuroparenchymal abnormalities than salespeople in the same age groups (table 5).

Sellers aged between 20 and 30 had a lower TCI (less than 0.50) than consumers in the same age groups. The proportion of sellers aged 40-50 with a TCI above 0.50 was significantly higher (p<0.05) than that of consumers (table 6). Sellers under the age of 20 were more likely to have a TCI above 0.50 than consumers.

**Table 4:-** Influence of age on sinus damage in sellers of adulterated petrol in southern Benin.

Variable	≤ 20		20-30		30-40		40-50		≥50	
	Vendor	Consumer	Vendor	Consumer	Vendor	Consumer	Vendor	Consumer	Vendor	Consumer
<b>Sinus disease</b>										
Yes	7.5±5.8a	12.5±7.2a	13.8±7.5a	17.5±8.3a	16.3±8.1a	7.5±5.8a	17.5±8.3a	6.5±5.4b	8.8±6.2a	2.5±3.4a
No	7.5±5.8a	17.5±8.3a	7.5±5.8b	21.3±9.5a	8.8±6.2a	8.8±6.2a	7.5±5.8a	6.25±5.3a	6.3±5.3a	3.75±4.2a
<b>Damage to the maxillary sinuses</b>										
Normal ventilation	7.5±5.8a	11.3±6.9a	5±4.8b	23.8±9.3a	10±6.6a	8.8±6.2a	11.3±6.9a	6.25±5.3a	6.3±5.3a	3.75±4.2a
Opacity	2.5±3.4a	6.3±5.3a	10±6.6a	15±7.8a	11.3±6.9a	7.5±5.8a	10±6.6a	6.25±5.3a	2.5±3.4a	2.5±3.4a
Reduced transparency	5±4.8a	10±6.6a	3.8±4.2a	0±0a	6.3±5.3a	0±0b	6.3±5.3a	0±0b	5±4.8a	0±0b
Frame thickening	1.3±2.4a	0±0a	0±0a	0±0a	2.5±3.4a	0±0a	1.3±2.4a	0±0a	0±0a	0±0a
<b>Attacks on the frontal sinuses</b>										
Normal ventilation	12.5±7.2a	12.5±7.2a	10±6.6b	31.3±10.2a	12.5±7.2a	13.8±7.5a	15±7.8a	12.5±7.2a	8.8±6.2a	5±4.8a
Opacity	0±0a	0±0a	5±4.8a	3.8±4.2a	3.8±4.2a	2.5±3.4a	7.5±5.8a	0±0b	0±0a	0±0a
Hypoplasia	0±0a	1.3±2.4a	0±0a	2.5±3.4a	1.3±2.4a	0±0a	0±0a	0±0a	0±0a	1.3±2.4a
Agenesis	0±0a	2.5±3.4a	0±0a	2.5±3.4a	0±0a	0±0a	0±0a	0±0a	1.3±2.4a	1.3±2.4a
Hypotrophy	0±0a	0±0a	0±0a	1.3±2.4a	0±0a	0±0a	0±0a	0±0a	0±0a	0±0a
Reduced transparency	0±0a	0±0a	1.3±2.5a	1.3±2.4a	1.3±2.5a	0±0a	1.28±2.5a	0±0a	1.3±2.5a	0±0a

CI: Confidence intervals; intra-class percentages of the same line followed by the same letter do not differ significantly at the 5% threshold.

**Table 5:-** Influence of age on lung damage in sellers of adulterated petrol in southern Benin.

Variable	≤ 20		20-30		30-40		40-50		≥50	
	Vendor	Consumer	Vendor	Consumer	Vendor	Consumer	Vendor	Consumer	Vendor	Consumer
No progressive pleuroparenchymal abnormalities	15±7.8a	11.3±6.9a	17.5±8.3b	37.5±10.6a	25±9.5a	15±7.8a	22.5±9.2a	12.5±7.2a	11.3±6.9a	6.3±5.3a
Uncoiling the thoracic aorta	1.3±2.4a	13.8±7.5a	0±0a	0±0a	1.3±2.4a	1.3±2.4a	5±4.8a	1.3±2.4a	1.3±2.4a	1.3±2.4a
Basal interstitial	0±0a	0±0a	1.3±2.4a	0±0a	0±0a	0±0a	1.3±2.4a	0±0a	1.3±2.4a	0±0a
Localized breast calcification	0±0a	0±0a	0±0a	0±0a	0±0a	1.3±2.4a	2.5±3.4a	0±0a	0±0a	0±0a
Blunt costodiaphragmatic cul-de-sac	0±0b	6.3±5.3a	0±0a	3.75±4.2a	0±0a	0±0a	1.3±2.4a	0±0a	0±0a	0±0a

Bilateral bronchial disease	2.5±3.4a	0±0a	0±0a	0±0a	2.5±3.4a	0±0a	1.3±2.4a	0±0a	0±0a	0±0a
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CI: Confidence interval; intra-class percentages of the same line followed by the same letter do not differ significantly at the 5% threshold.

**Table 6:-** Influence of age on the cardiothoracic index of sellers of adulterated petrol in southern Benin.

Variable	≤ 20		20-30		30-40		40-50		≥50	
	Vendor	Consumer	Vendor	Consumer	Vendor	Consumer	Vendor	Consumer	Vendor	Consumer
ICT<0.50	5±4.8a	11.3±6.9a	12.5±7b	35±10.5a	13.8±7a	11.3±6.9a	13.8±7.5a	8.8±6.2a	6.3±5.3a	3.8±4.2a
ICT=0.50	1.3±2.4a	3.8±4.2a	2.5±3.4a	2.5±3.4a	2.5±3.4a	2.5±3.4a	0±0a	2.5±3.4a	0±0a	1.3±2.4a
ICT>0.50	10±6.6a	2.5±3.4b	3.8±4.2a	1.3±2.4a	8.8±6.2a	2.5±3.4a	12.5±7.2a	1.3±2.4b	7.5±5.8a	1.3±2.4a

CI: Confidence interval; intra-class percentages of the same line followed by the same letter do not differ significantly at the 5% threshold

## Discussion:-

### Influence of exposure to doubtful quality gasoline on sinus status

Gasoline sellers show more abnormal sinuses (maxillary and frontal) than consumers. This difference can be accounted for the sellers' prolonged contact to gasoline in the course of their work. Nasal discharge, a sign of sinus damage, had already been reported in these gasoline sellers (Gbankoto et al., 2020a). The effect of gasoline on the sinuses and respiratory tract has been reported among gasoline sellers in Nigeria and Ghana (Nwokocha and Taiwo, 2014; Kuranchie et al., 2019). This sinus damage is due to the fact that the nostrils are the first receptors of inhaled petrol particles. The walls of the sinuses are lined with a respiratory-type mucosa that continues with that of the nasal cavity (Marieb, 2000). They are closely linked to the nasal cavities, with which they communicate. The mucus secreted by the sinus mucosa flows into the nasal cavities, resulting in secretions, rhinorrhea and nasal cavity damage, thus confirming the classic symptomatic triad of "sneezing, rhinorrhea and nasal obstruction" identified during the ENT consultation.

Airborne particles enter the respiratory system via the upper airways (Chuang et al., 2013; Wang et al., 2013). These particles are eliminated by sneezing and coughing, as reported by vendors (Gbankoto et al., 2020a). Some particles persist and are deposited in the maxillary and frontal sinuses, leading to the various abnormalities. The situations of reduced transparency and opacity in these sinuses, (more common among sellers) are observed in the total differences observed on radiograms. This sinus damage may be the cause of the nasal discharge and respiratory difficulties observed among petrol sellers (Tohon et al., 2015; Maksoud et al., 2019; Al-Harbi et al., 2020). These conditions caused by inhaled gasoline in the cause of the reactions reported in the respiratory system of exposed subjects (Owagboriaye et al., 2017).

Sinus abnormalities varied very little according to the age of the exhibitors. However, sellers aged between 20 and 30 showed more abnormal sinuses than consumers in the same age group. This finding depends on the fact that this age group is more exposed than the others, as they work more than 8 hours a day, whereas the other age groups work fewer hours a day (Gbankoto et al., 2020b).

### Influence of exposure to doubtful quality petrol on lung and heart condition

Exposure to doubtful quality gasoline increases the rate of pulmonary abnormalities, especially bilateral bronchopathy. Lung damage has already been reported in subjects exposed to gasoline (Sureshkumar et al., 2005; Caruso et al., 2015; Usemann et al., 2018). These lung injuries are caused by gasoline particles that have force their ways through the sinuses. In fact, gasoline generates particles 0.02 nm in diameter that settles in the bronchioles, causing inflammation of the airways (Srivastava and Barkule, 2020). An autopsy of the lungs of rats exposed to petrol vapor showed generalized hemorrhaging of the lungs (Monago et al., 2011). This hemorrhage could also be observed in human, as the observation of especially bilateral bronchopathy already shows that there is a problem (inflammation) in the lungs. The symptoms observed in these exposed rats were hypotonia, drowsiness, narcosis and colonic spasms leading to death from respiratory failure. With the exception of death, all these symptoms have been previously reported in people exposed to gasoline (Lee et al., 2010; Nwokocha and Taiwo, 2014; Gbankoto et al., 2020a; Srivastava and Barkule, 2020). Age has little influence on pulmonary expectations except for progressive

pleuroparenchymal abnormalities, which were more observed in sellers aged 20-30 years. This finding is linked to the fact that exposure is longer in this age category, which works more hours per day than others (Gbankoto et al., 2020b).

Essence sellers are more predisposed to high blood pressure, as they have more ICT above 0.5. This finding confirms the observations of Eloundou (2016) in Cameroon, who describes high blood pressure among gasoline vendors. Apart from hypertension, other conditions affecting the heart and nervous system, such as progressive reduction in intellectual capacity, depression, and physical and mental fatigue, have been noticed among people in contact with gasoline (Caruso et al., 2015; Eloundou, 2016). Very young people (under 20) and older people (over 40) are more predisposed to cardiovascular disease, especially hypertension, as their ICT is greater than 0.05.

### Conclusion:-

A study of the influence of exposure to doubtful quality petrol on the sinuses, lungs and heart in southern Benin sellers shows that inhaled petrol particles is the source of the appearance of sinus anomalies by reducing their transparency. In the lungs, doubtful quality petrol causes bilateral bronchopathy. Exposure to gasoline also raises the cardiothoracic index, especially in the elderly. The age of exposed individuals has little influence on sinus and lung abnormalities. In the case of an age effect, individuals aged between 20 and 30 are more susceptible to sinus and lung disorders.

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