Evaluation Of The Level Of Exposure To Benzene And The State Of Health Of The Workers Of "ORYX-BENIN SA".

AÏKOU Nicolas [1, 2,3,] Serge ADE[1], [2,3], R.A. LAPO[1,3] ; COULIBALY Founzégué Amadou [1,2]; AHOYO. Angèle Théodora [1, 2,3.] Gominan MOUTAWAKILOU [1,2,3.] AÏKOU Nadine Lucrèce. Mirèze. [1, 2, 3.] AÏKOU Arielle Nadège Emérentienne [1, 2, 3.] Lydie ZANNOU[1, 2],[3.] Ibrahim ALKOARE [1, 2, 3].

Corresponding author:
Dr. AÏKOU Nicolas: National University of Sciences, Engineering and Mathematics
Department of Human Biology
Laboratory of Clinical Biochemistry and Medical Microbiology
aikounicolas@yahoo.fr, nicolashoundjo@gmail.com,
04 BP 435
Tel : 00229 95059832

ABSTRACT

Aim: To evaluate the level of exposure to benzene and the state of health of the workers of "ORYX-BENIN SA". It is a descriptive and analytical cross-sectional study aimed at evaluating the level of exposure to benzene in 18 workers of " ORYX-BENIN SA ".

Materials and Methods: It was carried out with their informed consent and after they had completed a questionnaire. The data collection was carried out by questionnaire, a direct observation grid, a summary clinical examination of the workers and a composite biological assessment: Blood count and leucocyte count by the Culter method and the determination of urinary phenol by the nitro-4-aniline spectrophotometric method.

Results: 55.55% of the workers are between 26 and 40 years old. They are all male. 61.11% of the workers have less than one year of experience and 22.22% have at least three years of experience. All the workers, grouped in three shifts, work 8 hours a day. None of the workers wear a mask while working. The only means of protection used by all workers are gloves, gowns and safety shoes. No agent of this company works with his back to the wind. The clinical manifestations recorded during the survey are 50% nausea, 38.89% asthenia and 16.16% eye irritation. A total of three chargers show hematological signs of benzene intoxication. The rate of urinary phenol is largely higher than 250 mg/g. of creatinine at the end of the shift.

Conclusion: It is observed that the inversion of the leucocyte formula is moderate in only one charger while it is severe in five and very severe in six. All of the loaders involved in this study were exposed to benzene at more than 25 ppm per working day.

Keywords: benzene, urinary phenol, exposure level, loading activity.

INTRODUCTION

The first known occupational intoxications were the sartunism of lead miners in the time of Hippocrates. The chemicals responsible for occupational intoxication are numerous and include various sub-categories. Benzene is one of these dangerous and toxic chemicals [1-2]. Benzene $_{C6H6}$, is a colorless, volatile liquid with a characteristic odor (aromatic). It is highly flammable and its vapors are explosive. It is sparingly soluble in water, but miscible with most organic solvents and mineral, vegetable or animal oils [2]. The main sources of exposure are the petroleum, chemical and petrochemical industries [3]. Also the perfume industry, the manufacture and use of synthetic glues in footwear, leather and rubber goods and furniture. It is also found in laboratories using benzene as an organic synthesis material or as a chromatography solvent [4, 5]. It is found in the transport, distribution and use of fuels (gasoline generally contains 1 to 5% benzene). Benzene is also present in cigarette smoke, which partly explains its presence in the exhaled air of non-occupationally exposed smokers. In an occupational setting, benzene is mainly absorbed through the respiratory tract and to a lesser degree through the skin. The digestive tract is accidental [5]. After inhalation, the quantity absorbed represents 40 to 60% of the quantity inhaled [2]. The fate of benzene in the body has been the subject of numerous investigations. After absorption, it is partly eliminated unchanged in the urine (less than 1%) and in the exhaled air (10 to 50% depending on physical activity and the amount of fat tissue); the rest is bio-transformed. The first step in the oxidation of benzene is the formation of benzene epoxide under the action of mixed-function oxidases in the liver. The main final metabolite is phenol, which is excreted in the urine, either conjugated with sulfuric or glucuronic acid or in free form. A small amount is metabolized to catechol, hydroquinol and then hydroquinone, trans-muconic acid and carbon dioxide. These main metabolites of benzene (benzene epoxide, catechol, hydroquinol, hydroquinone) are

considered responsible for its myelotoxic action with a particular emphasis on hydroquinone which has been shown to be the most inhibitory of DNA synthesis [2, 5]. When one visits the workplaces of " ORYX-BENIN SA" agents, one wonders if this benzene does not have an adverse effect on their health. It is to answer this question that we have chosen this subject to evaluate the level of exposure to benzene of these workers. The results obtained allowed us to draw conclusions and to suggest practical conditions for a better monitoring of the health of these workers.

PATIENTS AND METHODS

Our study took place in the company "ORYX-BENIN SA" It is a subsidiary of the ADDAX ORYX Group (ADDAX ORYX GROUP: AOG) established in several countries around the world. It should be noted that the activities of ORYX BENIN SA are mainly focused on the import and distribution of hydrocarbons and domestic gas (butane). This is a descriptive and analytical cross-sectional study from January to July 2018, aimed at assessing the level of exposure to benzene among the workers of " ORYX-BENIN SA ". It covers 18 (eighteen) workers working at the loading station.

In order to assess the level of benzene exposure of the workers involved in this study, a questionnaire survey was carried out which included closed and open questions; a direct observation grid through workplace visits; a summary clinical examination of the workers; and a composite biological assessment :

- Blood count and white blood cell count by the Culter method;
- Determination of urinary phenol by the spectrophotometric method with nitro-4-aniline

In this study we also used acute and chronic toxicity data to assess the level of benzene exposure of workers.

Acute toxicity is observed following short-term inhalation exposure and is responsible for central nervous system depression with clinical manifestations such as drowsiness, dizziness, vertigo, excitement and benzene intoxication, headache, nausea, asthenia, loss of coordination, confusion and even loss of consciousness. These symptoms are reported for exposures greater than 5ppm. 2] Exposure to a concentration of 20,000 ppm is rapidly fatal according to the results of International Labour Office experts [6, 2]. Benzene is a moderate irritant, but it is not a skin sensitizer [2]. Benzene vapors are responsible for eye irritation, but no permanent injury is documented. In case of accidental ingestion, pneumopathic lesions may be observed. The lethal oral dose is estimated at 15mL of pure benzene for adults [5] No effects on the blood and immune system are observed with short-term exposure. In this case, the central nervous system (CNS) is the primary target.

Chronic toxicity, given the degreasing action of benzene, repeated contact can cause redness, dryness and cracking of the skin. In fact we have an irritation of the skin and mucous membranes. The most notable toxic effect of long-term exposure to benzene is an insidious and often irreversible alteration of the bone marrow via its metabolites [2]. Individual susceptibility and hematological findings vary widely. Thrombocytopenia, leukopenia or anemia, or one of these disorders (pancytopenia) are classic symptoms. These disorders can occur within a period of 3 months to 17 years [5]. The prognosis for pancytopenia is favourable in the majority of workers if they are removed from exposure, although some changes in blood counts may last for several years.

In practice, the following hematological signs must be recognized as evidence of intoxication and not only of benzene impregnation [5] :

- Red blood cell: less than 3.900.000 GR/ml in men and less than 3.700.000 GR/ml in women ;
- Hematocrit: less than 35% in men and less than 33% in women;
- White blood cells: less than 3500GB/ml ;
- Neutrophils: less than 1200/ml ;
- Platelets: less than 150000/ml.

This benign disorder characterized by a decrease in the number of blood cells that make up benzenism has become exceptional in developed countries due to reduced levels of exposure; in fact, it is a reversal of the blood count, which may go unnoticed if anemia were not present. When exposure persists, benzene causes leukemia, which can occur even years after exposure has stopped.

But according to more recent studies, it is the inversion of the leucocyte formula that is much more indicative of benzene intoxication.

The EPA (Environmental Protection Agency) estimates that a lifetime exposure to 1ppm benzene can lead to a further increase in leukemia mortality of 22/1000 [5].

Statistical analysis

Values are averages ± sd. Statistical analysis of the data is performed using STATISTICA (version 4.1; Stat-Soft, Paris, France). The data were evaluated by analysis of variance. Differences were considered significant when $P<0.05$.

RESULTS

Refer to the tables and figures at the end of the documents

DISCUSSION

The majority of the workers in our study (55.55%) are between 30 and 40 years of age. NISSE and collaborator [7] in a cross-sectional study conducted among fuel transporters in the Nord-Pas de Calais region in 1996 found an average age of 39 years. More than half of the workers (61.11%) have less than one year's experience, while 22.22% have at least three years' experience, compared with 10.7 years in the NISSE and collaborators study [7].

None of the workers wear a mask during their activity, whereas in the workplace, benzene is essentially absorbed through the respiratory tract. The only means of protection used by all workers are gloves, gowns and safety shoes, and skin absorption is therefore very low. Working conditions do not allow any loader in this company to work with his back to the wind. All these considerations are factors that justify how often these workers are exposed to the risks associated with benzene.

The clinical manifestations found in our survey (Table I: Clinical manifestations according to seniority) are mainly nausea, asthenia, dizziness, respiratory tract irritation and eye irritation. Subjects with <12 months seniority; 24-36 months seniority and ≥36mois complained mostly of nausea. Vertigo is only reported after 12 months of seniority. Asthenia already appears at 45.45% in subjects with <12 months seniority. Dyspnea at work was found to be 50% at 24-36 months and respiratory tract irritation at 27.27% at <12 months seniority; as well as eye irritation at 18.18%. For the INRS [8], these symptoms appear at varying concentrations depending on the individual: no effect at 25 ppm, headache and asthenia from 50 to 100 ppm, symptoms more accentuated at 500 ppm, tolerance only for 30 to 60 minutes at 3000 ppm, death in 5 to 15 minutes at 20,000 ppm [9,10].

The results of the blood count (Table III) reveal that the No. 10 loader has a Red Blood Cell count of 2600x103/ml and a Hematocrit of 24% are very low. Chargers No. 15 and No. 17 have very low platelet levels at 130G/L and 132G/L respectively. So three chargers, i.e. 16.66%, have hematological signs of benzene intoxication. The absence of certain assessments such as the medullogram and the short seniority at work do not allow us to highlight cases of leukemia.

The standard of urinary phenol = 250 mg/g. of creatinine at the end of the post on the WWW.inrs.fr site is used as a reference [[11, 12]. The results of the urinary phenol mg/g balance sheet (Curve1), show that all chargers have a very high urinary elimination reflecting an exposure of more than 25 ppm. The standard is 5 ppm per working day [13,14].

In the French literature, an excess of leukemia and myeloma is only observed for old exposures occurring 20 years after the first exposure according to IRELAND and al [15,16] in 1997 or is significant only in workers with 15 years of seniority or more in the company and in those with 30 years of working life according to CONSONNI and al [17,18] in 1999. Opinion shared by the International Agency for Research on Cancer (IARC) which certifies the leucomogenicity of benzene is for exposures above 100 ppm [19,20].

On the other hand, RAABE and WONG [21,22], in 1996 in the oil industry of the United States and the United Kingdom and in 1997 did not find an increase in leukemia of any type. These results were confirmed by the same authors in 1997 not in this industry but also in the oil industry of Canada and Australia [23]. SCHNATTER in 1996, RUSHTON and ROMANIUK in 1997 and WONG in 1999 found no relationship between the occurrence of leukemia and chronic exposure to low levels of benzene in gasoline distribution employees. This finding was contradicted by WESTLEY-WISE et al. in 1999 [24], who found an outbreak of leukemia at very low levels of benzene in the WARRAWONG region of Australia [25].

CONCLUSION

Symptoms of acute benzene intoxication alone or in combination reported by workers are nausea, dizziness, and tingling in the eyes during or immediately after loading. A total of 12 of the 18 respondents reported burns. It was observed that all the loaders involved in this study had very high levels of urinary phenol at the end of the working day, reflecting an exposure of more than 25 ppm. The standard is 5 ppm per working day. The inversion of the leucocyte formula is moderate in one charger, while it is severe in five and very severe in six.

ACKNOWLDGMENTS

We would like to thank the Director of the SPACE-LABM Laboratory; who made it possible to carry out this study not only in his Laboratory, but the study could be carried out on the Laboratory's own funds. Our sincere thanks also go to all the staff of the Laboratory who supported us in various ways in the realization of this study. To the authors, we also say thank you very much for the work accomplished, but we ask them to arm themselves with ardor; with self-sacrifice; with dynamism; with rigor in Scientific Research, because much remains to be done in the field of Scientific Research.

CONTRIBUTION OF THE AUTHORS

All the authors contributed favorably to the realization of this study. Each of us played his or her score until the manuscript was written. After the first manuscript, they all worked for ; the completion of the final version. They even remain ready in case of eventual corrections to work towards a successful publication of our original research article.

CONFLICT OF INTEREST

There are no conflicts of interest of any kind. We have all worked in a cordial and collegial manner.

REFERENCES

1- WHO Consumer Safety Commission (CSC) Advice on benzene in fuels. Report of the French Public Safety Society; Paris 1997; p4.

2- REPUBLIC OF BENIN :

- Decree N° 2001-110 of April 04, 2001 fixing the measures of air quality in the Republic of Benin.

- Order N°022/MFPTRA/DC/SGM/DT/SST relating to general measures of Health and Safety at work.

- Law No. 98-004 of January 27, 1998 on the Labor Code in the Republic of Benin.

3- INRS: Benzene. Updated April 11, 2002 and March 20, 2003. www.inrs.fr

4- INRS : Phenol **:** Urine. UCL. Unité de Toxicologie Industrielle et de Médecine du Travail ; Paris 2002 ; p2

5- LEMAHIEU T. Those sentinels that society does not want to see. SANTE 2001 Company. www.humanite.presse.fr/journal/index.html

6- INRS: "Benzene". Fiche toxicologique N° 49. 1997, 6p. htt:/www.inrs.fr/produits/pdf/nd2174.pdf

7- NISSE C. and collaborator : Evaluation of benzene exposure in fuel carriers. XXV National Days of Occupational Medicine; Strasbourg 1996; 430-432.

8- ILO: International Center for Occupational Information, Safety and Health. OHS legal texts: Determination of benzene concentration in the workplace; monitoring of workers' health for the prevention of occupational exposure to benzene. Revista CIPA; Brazil 1996; CIS Number 066496.

9- INRS : Table 4 of occupational diseases related to benzene.

10- BERTOLA M. Environment : The last drop of super. Kiosque à la une (N°3), CSI- Sciences actualité, Paris 2000.

11- BREYER H. Draft report on limit values for benzene and carbon monoxide in ambient air. Committee on the Environment, Public Health and Consumer Policy. European Parliament, Paris 1999; PE 231. 368/ Am. 16-22

12- **TP:** The legal Framework. Science Santé BTP Arrêté du 21 janvier 2002 portant agrément d'organismes habiletés à procéder aux contrôles de la concentration en benzène de l'atmosphère des lieux de travail ; Paris 2002.

13- Canadian Centre for Occupational Health and Safety (CCOHS) OHS Responses: Health Effects of Benzene, Canada 1997.

14- Conseil National de l'Air (CNA) Avis relatif à la proposition de directive communautaire sur le benzène et le monoxyde de carbone dans l'air ambiant, Paris 1999 ; 0622 - p1

15- Federal Department of the Environment, Transport, Energy and Communications (DETEC) : Too much benzene in the air. Report of the Federal Commission for Air Hygiene (CFHA), Bern 2003.

16- ECETOC : Technical rapport N°16. A review of recent literature on the toxicology of benzène. Brussels, Ecetoc, 1984.

17- GONZALEZ M., VELTEN M.,CANTINEAU A. Evaluation of solvent exposure in an epidemiological study of 249 employees. XXV Les Journées Nationales de Médecine du Travail; Strasbourg; 1996: 432-434.

18- Government of Canada Benzene in gasoline. Aboriginal Business Service Network Canada 2003; 22 (2375): p3.

19- Government of Canada: Environment Canada Measures of Benzene in the Canadian Atmosphere. NAPS Annual Reports. NAPS Publications; Canada 1998.

20- Government of Canada: Environment Canada Federal Smog **Regulations.** Canadian Environmental Protection Act (CEPA). Report of the Commissioner of the Environment and Sustainable Development. Chapter 4.13: p2

21- International Agency for Research on Cancer (IARC) Global assessments of carcinogenicity to humans. IARC Monographs 1987; Volumes 1-82.

22- ICEM : ICEM **Regional Office for North America** ICEM Safety Data Sheet: Benzene; 1998.www.iceamna.org

23- Canadian Legal Information Institute: Benzene in Gasoline Regulations. LAWS, Canada SOR/ 97-493.

24- Canadian Petroleum Products Institute (CPPI). Gasoline quality data. Environmental Performance; 2003. Htt://www.icpp.ca/fr/essence.htm

25- Institut français de l'environnement (Ifen) Benzène : Attention danger ! Les brevets du moment ; France 2001.

Table II: comparison of an intoxicated individual to a normal individual

Subject Normal					Subject intoxicated with benzene			
		values	%				Values	%
Granulocytes :	Neutrophils	45000	65		Granulocytes :	Neutrophils	125 (5%)	65
	Basophils	280	4			Basophils	75 (3%)	4
	Eosinophil	70	1			Eosinophil	180 (7%)	1
Monocytes :		700	10		Monocytes		700 (30%)	10
Lymphocytes :		1400	20		Lymphocytes		1400 (55%)	20
Total :		7000			Total		2480	

1- Characteristics of surveyed workers

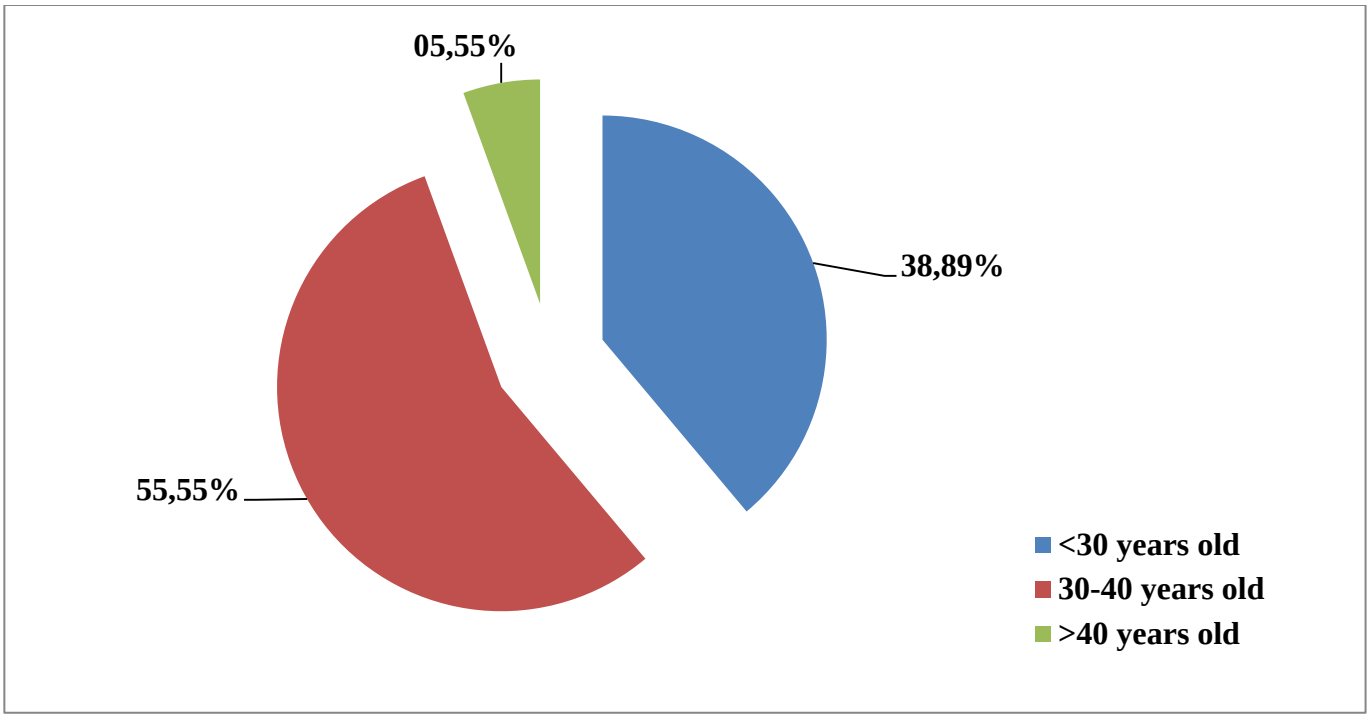


Figure 1: Distribution of Workers by Age

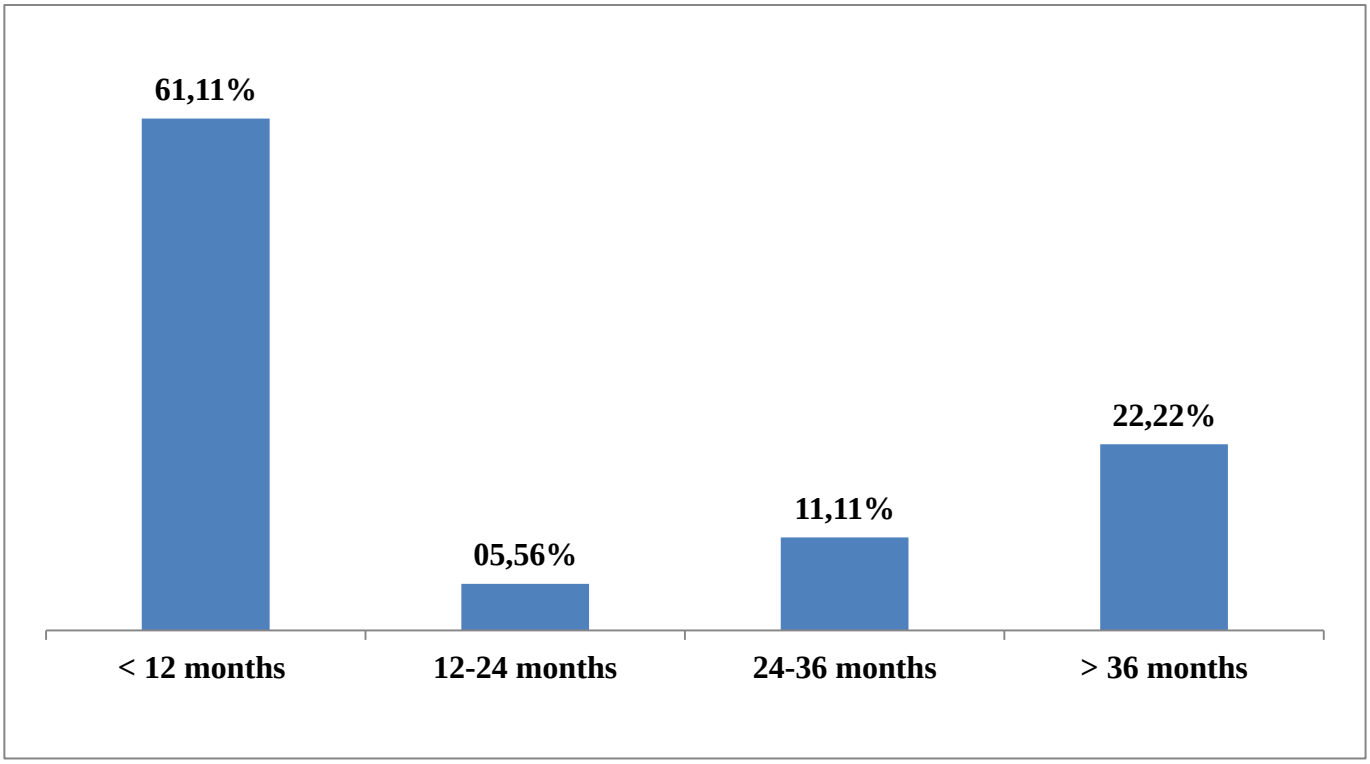


Figure 2: Distribution of workers by seniority in the loader position

2- Protective measures

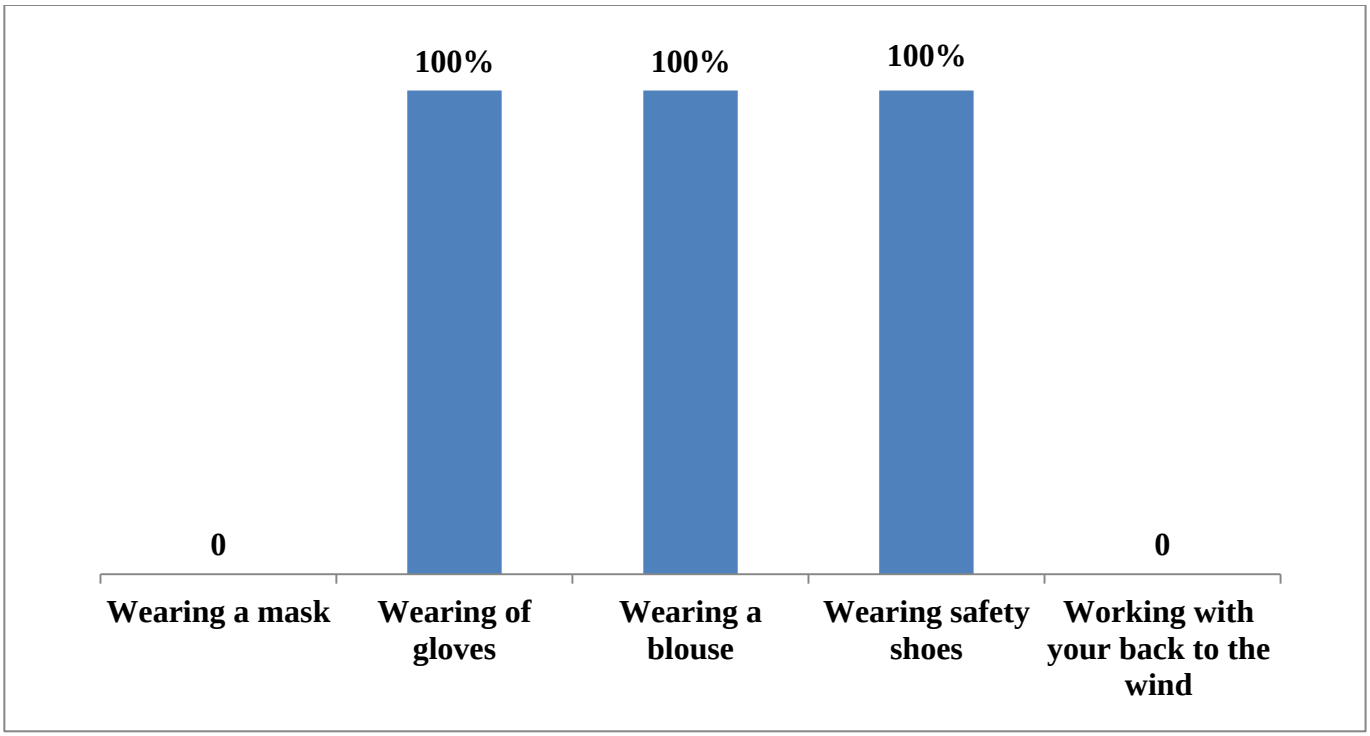


Figure 3: Distribution of Workers by Protective Measures

3- Clinical manifestations according to seniority

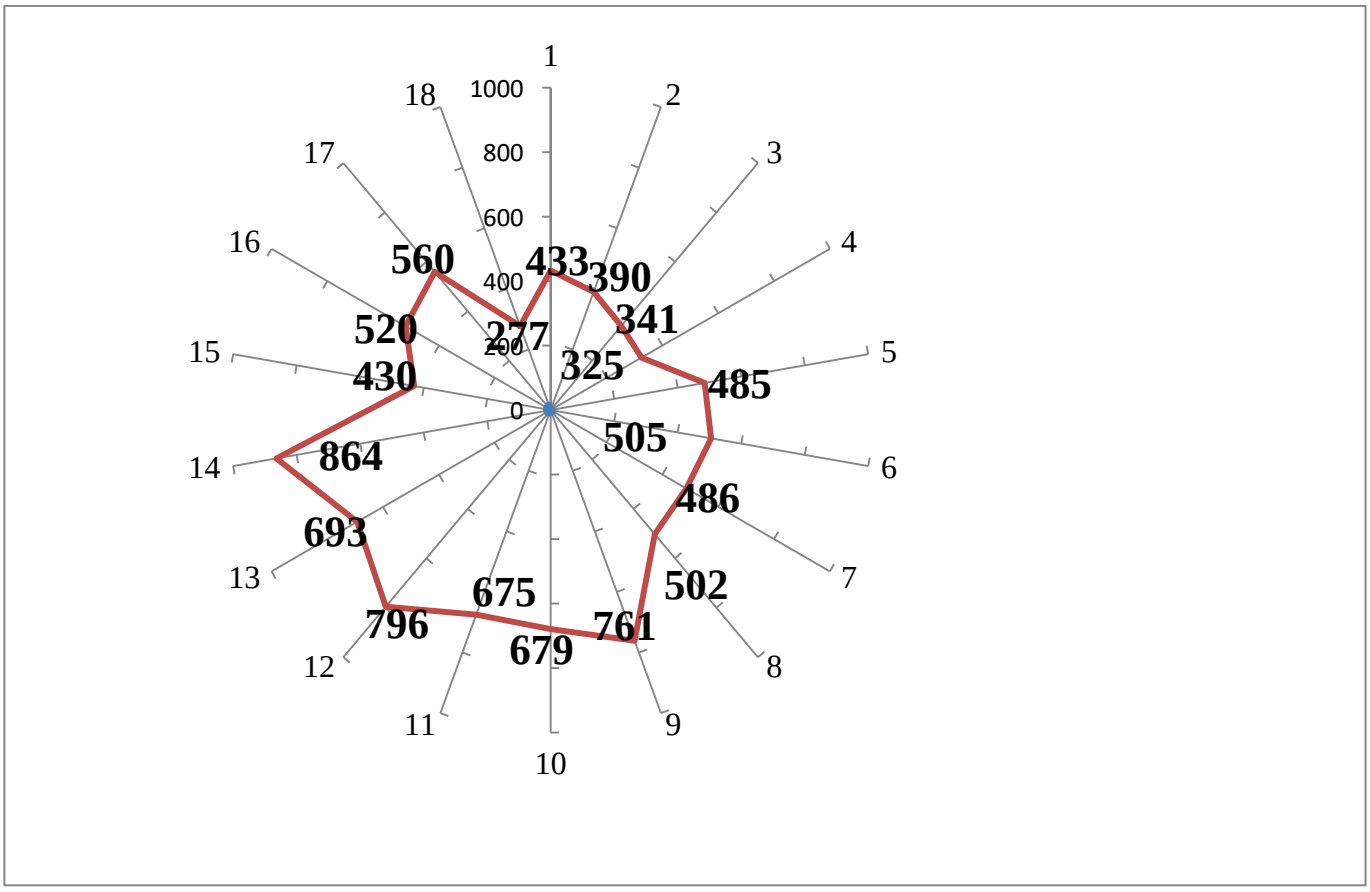
Table III: Clinical manifestations according to seniority

Seniority	< 12 months (11)	12 - 24 months (1)	24 - 36 months (2)	> 36 months (4)
Nausea	6 (54,54%)	0	1 (50%)	2 (50%)
Vertigo	0	1 (100%)	2 (100%)	1 (25%)
Asthenia	5 (45,45%)	1 (100%)	0	1 (25%)
Dyspnea at work	0	0	1 (50%)	0
Irritation of the respiratory tract	3 (27,27%)	0	0	0
Eye irritation	2 (18,18%)	0	0	0

1- Results of the bioassessment

Table IV: blood count results

Charger No.	GB/ml	Hematocrit (%)	Neutrophils/ml and % of	Brochures /ml	GRx103/ml
1	6300	39	1890 30%	191000	4300
2	6800	38	3672 54%	199000	4200
3	9200	41	6164 67%	270000	4550
4	4700	47	1974 42%	249000	5200
5	4000	43	1640 41%	288000	5200
6	3800	48	1520 40%	246000	5300
7	4400	44	2552 58%	219000	4800
8	12900	43	7740 60%	320000	4650
9	5300	43	2438 46%	310000	4700
10	3800	24	2280 60%	345000	2600
11	5200	41	2392 46%	396000	5000
12	4200	39	2268 54%	400000	4200
13	10400	40	6448 62%	292000	4400
14	11800	44	4485 38%	260000	4800
15	4400	35	2112 48%	130000	3800
16	5200	41	3016 58%	250000	4600
17	8100	38	5022 62%	132000	4200
18	7200	44	4608 64%	222000	4900



Curve 1: results of the urinary phenol test in mg/g. creatinine at the end of the shift.