EFFECT OF MACHINE NOISE ON BLOOD PRESSURE: THE CASE OF SAWMILL WORKERS IN BENIN.

Abstract:

This study aims to evaluate the effects of machine noise on the blood pressure of workers at the BOSTONE SERVICE sawmill in Benin. Workers' blood pressure was measured using an automatic sphygmomanometer before and during noise exposure, in accordance with the 2016 recommendations of the French National Authority for Health (HAS) and the French Society of Hypertension (SFHTA). The continuous equivalent sound pressure levels (Lp,A,eqT) were recorded. and peak sound pressure levels Lp,C,peak were measured with the BSWA 308 integrating sound level meter, calibrated to class 1 and accuracy 0.7, in accordance with the task measurement expertise method of ISO 9612:2009. The calculator downloadable from the INRS website in France was used to process the data to obtain the daily noise exposure level $LEX_{,8h}$ = 84.8 dB(A). and the expanded uncertainty U=2.5 dB(A). The peak sound pressure level measure is Lp,C,peak = 121.4 dB(C). We note that the $L_{EX,8h}$ = 84.8 exceeds 80 dB(A), a threshold The maximum noise level in industrial settings, according to ISO 9612:2009, the French Noise Information and Documentation Center (CidB) , and Decree No. 2022-301 of May 25, 2022, regulating noise in Benin, is not to be exceeded. Furthermore, blood pressures measured during work are significantly higher than those measured before noise exposure. This study shows that the noise from the machines has an effect on the blood pressure of sawmill workers. BOSTONE SERVICE . Thus, To avoid high blood pressure, these workers must protect themselves with PICB (Personal Protection Against Noise) such as noise-canceling headphones and earplugs.

Key words:-
Noise exposure level, blood pressure, integrating sound level meter, blood pressure monitor

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Introduction:-

Similar to the research conducted by Brahem et al. at a power and gas plant in Tunisia [1] on the impact of occupational noise on the development of hypertension , this article aims to demonstrate the effects of machine noise on the blood pressure of sawmill workers BOSTONE SERVICE located at Abomey-Calavi in Benin. It should be noted that noise has an aggressive aspect that is very often overlooked by most people [2]. As we demonstrated in our Master's thesis and an article published in HALL, noise negatively impacts acoustic comfort [3,4]. The World Health Organization (WHO) has also recently developed guidelines on noise, based on its harmful effects on health. Even the government of Benin has issued a new decree to regulate noise [5] **.** Despite the existence of these regulations, workers in some industries are exposed to very high noise levels for extended periods. Regular exposure to intense machine noise leads to serious illnesses, including hypertension. Indeed, several epidemiological studies have shown that noise can increase the risk of hypertension in adults [6].This condition imposes a heavy

social and financial burden on those affected, their families, and the nation. It is in view of this reality that we carried out the study on the **effects of machine noise on the blood pressures of workers at the BOSTONE SERVICE sawmill** in order to help these workers avoid the disease of high blood pressure. The materials and methods used to conduct this study, as well as the analysis and interpretation of the results, are presented as follows.

Materials and Methods:-

Blood pressure and noise exposure levels of workers were measured on Saturday, September 13, 2025, between 10:00 a.m. and 3:00 p.m.at the BOSTONE SERVICE sawmill. Ethically**,** authorizations from the owner of the BOSTONE SERVICE sawmill **and** informed consent from all workers were obtained. The details of the materials and methods used are below.

Materials for measuring blood pressure of workers at the BOSTONE SERVICE sawmill:-

The materials used to measure blood pressure of workers are:

- automatic blood pressure monitor;
- armband;
- pen ;
- notebook.

The photos 1 and 2 show the automatic blood pressure monitor and the armband that were used.

Photo 1: Automatic blood pressure monitor

Photo 2 : Armband

Methods for measuring blood pressure of workers at the BOSTONE SERVICE sawmill:-

The method used to measure the blood pressure of workers at the BOSTORNE SERVICE sawmill is that recommended by the French National Authority for Health (HAS) and the French Society of Hypertension (SFHTA) in 2016 [7]. The number of workers included in the blood pressure measurement was three out of the six workers considered in the study; this was based on the sample of workers selected for noise level measurement. For each worker, blood pressure was measured at the beginning of the workday (before noise exposure) and at midday (during noise exposure). Blood pressure was measured twice: in each worker's right and left arm, in a seated position, as **systolic pressure** (**SBP**) when the heart contracts and **diastolic pressure** (**DBP**) when the heart relaxes. For each worker, the measurement considered is that of the arm where the blood pressure reading is higher. Photos 3 and 4 below show, respectively, a machine at the BOSTONE SERVICE sawmill and a worker's blood pressure measurement.

Photo 3 : BOSTONE SERVICE sawmill

Photo 4: Blood pressure measurement of a worker at the BOSTONE SERVICE sawmill

Materials for measuring noise exposure levels for workers at the BOSTONE SERVICE sawmill:-

The materials used to measure noise exposure levels are:

- BSWA 308 brand integrating sound level meter, class 1 and accuracy 0.7;
- foam windproof ball;
- computer TOSHIBA ;
- software or calculator downloaded from the website of the INRS (National Institute for Research and Safety) of France.

The photos 5 and 6 show the integrating sound level meter and the computer that were used.

Photo 5: Integrating sound level meter BSWA 308, class 1, accuracy 0.7

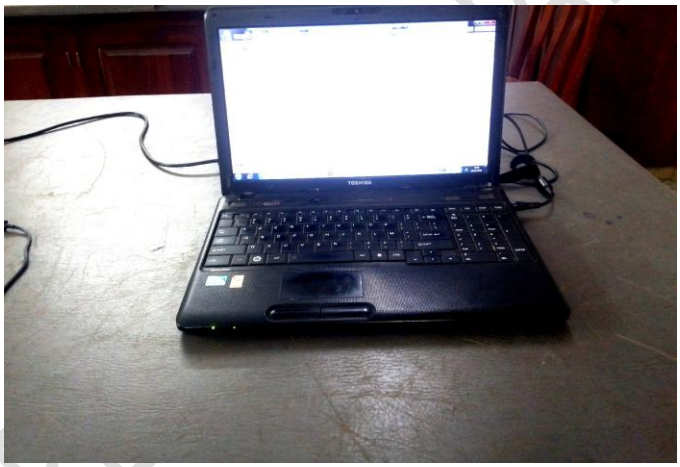

Photo 6 : Computer TOSHIBA

Methods for measuring noise exposure levels for workers at the BOSTONE SERVICE sawmill:-

Measuring noise exposure levels for workers at the BOSTONE SERVICE sawmill The measurement was carried out on Saturday, September 13, 2025, between 10:00 a.m. and 3:00 p.m. The task-based measurement method of ISO 9612:2009 [8] was used. This method was selected after a preliminary analysis of the work performed by the BOSTONE SERVICE sawmill workers and an estimation of the task duration in accordance with the requirements of ISO 9612:2009 [8]. It was observed that the sawmill workers performed the task of machine sawing for a daily duration of 7 hours and 30 minutes, after deducting breaks or rest periods. The **equivalent continuous sound pressure levels Lp,A,eqT Peak sound pressure** levels **(Lp,C,peak)** were measured using a calibrated, Class 1, 0.7-accuracy BSWA 308 integrating sound level meter. Three measurements of equivalent continuous sound pressure levels (Lp,A,eqT) were taken, each lasting 5 minutes. Measurements were taken on a sample of three

workers out of a workforce of six performing the lumber cutting operation in the sawmill. Indeed, for the task-based measurement method, ISO 9612:2009 [8] recommends three measurements per task if the difference between these three measurements does not exceed 3 dB. However, when the difference between the three measurements exceeds 3 dB, the standard requires three additional measurements. The minimum duration of a measurement is set at 5 minutes. During the measurements, the sound level meter's microphone is positioned 40 cm from the worker's ear.

The software or calculator [9] downloaded from the website of the French INRS (National Institute for Research and Safety) was used to process the **equivalent continuous sound pressure levels Lp,A,eqT** to obtain the **daily noise exposure level $L_{EX,8h}$** of the workers the BOSTONE SERVICE sawmill and the **expanded uncertainty U** of the measurement **.**

Results:-

The results of the blood pressure measurements and noise exposure levels of the workers considered by the study are as follows.

Results of the blood pressure measurement of workers at the BOSTONE SERVICE sawmill:-

The results of the blood pressure measurement of the sawmill workers are recorded in Tables 1, 2 and 3 below:

Table 1: Blood pressure measurement of the first sawmill worker

	Before work		During the work	
	Right arm	Left arm	Right arm	Left arm
Systolic	111	130	186	74
Diastolic	60	60	160	55

Table 2: Blood pressure measurement of the 2nd sawmill worker

	Before work		During work	
	Right arm	Left arm	Right arm	Left arm
Systolic	109	110	118	112
Diastolic	67	72	80	75

Table 3: Blood pressure measurement of the 3rd sawmill worker

	Before work		During the work	
	Right arm	Left arm	Right arm	Left arm
Systolic	110	114	116	130
Diastolic	70	69	65	116

In accordance with the 2016 recommendation of the French National Authority for Health (HAS) and the French Society of Hypertension (SFHTA) [7], for each worker, the blood pressure measurement considered or retained is that of the arm where the measurement is highest. Thus, the summary of measurements for the three workers is presented in Tables 4, 5, and 6.

Table 4: Blood pressure measurement considered for the first sawmill worker

	Before work	**During work**
Systolic	130	186
Diastolic	60	160

Table 5: Blood pressure measurement considered for the 2nd sawmill worker

	Before work	**During work**
Systolic	110	118
Diastolic	72	80

Table 6: Blood pressure measurement considered for the 3rd sawmill worker

	Before work	**During work**
Systolic	114	130
Diastolic	70	116

Results of the measurement of workers' noise exposure levels:-

The results of the measurements of the equivalent continuous sound pressure level Lp,A,eqT and peak sound pressure level Lp,C,peak are recorded in Table 7 below.

Table 7: Measurement of equivalent continuous sound pressure levels Lp,A,eqT and peak sound pressure levels Lp,C,peak

Sawmill workers	**Lp,A,eqT**	**Lp,C,peak**
1st Worker	83.1 dB(A)	121.4 dB(C)
2nd Worker	85.6 dB(A)	
3rd Worker	86.0 dB(A)	

The photo 7 show the measurement of equivalent continuous sound pressure levels Lp,A,eqT.

Photo 7: Measurement of equivalent continuous sound pressure levels Lp,A,eqT

These measured values of equivalent continuous sound pressure levels Lp,A,eqT were processed using the software or calculator [9] of the INRS (National Institute for Research and Safety) of France to obtain, on the one hand, the daily noise exposure level $\mathbf{L_{EX,\ 8am}}$ workers at the BOSTORNE SERVICE sawmill and, on the other hand, the expanded uncertainty **U** of the measurement. Thus, the daily noise exposure level obtained with the software or calculator is $\mathbf{L_{EX,8h}}$ **= 84.8 dB(A)** and the expanded uncertainty is **U= 2.5 dB(A)** (see tables 8 and 9 below).

Tableau 8 : Détermination du niveau de pression acoustique continu équivalent moyen Lp,A,eqT,m avec le logiciel ou la calculette de l'INRS [9]

ISO 9612

Task-Based Measurement :

Yellow cells
Green cells
Purple cells

Results related to data entry		Task	
	Task name	**Sawing wood**	
Noise level	Sample number	Noise level (dB)	Duration (h)
$L_{EX,8h}$ = **84.8 dB**	1	83.1	7.5
	2	85.6	7.5
Task defined Number **1**	3	86	7.5
Total duration (h) **7.5**			
	Measuring instrument	u2	
		0.7	
Number of measured values		3	
Lp,A,eqT,m: average level		**85.1**	
Uncertainty type u1a		0.9	
Tm: Task duration m (h)			**7.5**
Uncertainty type u1b			0.0

Tableau 9 : Détermination du niveau d'exposition quotidienne $L_{EX,8h}$ et l'incertitude élargie U avec le logiciel ou la calculette de l'INRS [9]

Task-based measurement

Daily noise exposure level	**84.8**	**dB (A)**
Expanded uncertainty	**2.5**	**dB (A)**

Summary of uncertainties		(references)	Symbols, relationships	Task 1
Noise level	Standard uncertainty	(C.6)	$u_{1a,m}$	0.91
	Sensitivity coefficient	(C.4)	$c_{1a,m}$	1.00
Duration	Standard uncertainty	(C.7)	$u_{1b,m}$	0.00
	Sensitivity coefficient	(C.5)	$c_{1b,m}$	0.58
Uncertainty term related to noise level			$c_{1a,m} * u_{1a,m}$	0.91
Uncertainty term related to task duration			$c_{1b,m} * u_{1b,m}$	0.00
Uncertainty term related to the measuring instrument			$c_{1a,m} * u_{2,m}$	0.70
Uncertainty term related to microphone position			$c_{1a,m} * u_{3}$	1.00

Discussion:-

Tables 4, 5 and 6 show that, at the level of the three workers in the chosen sample, **systolic/diastolic** blood pressures measured are such that:

For the first worker, we have :

- **130 / 60** (before work)
- **186 / 160** (during work)

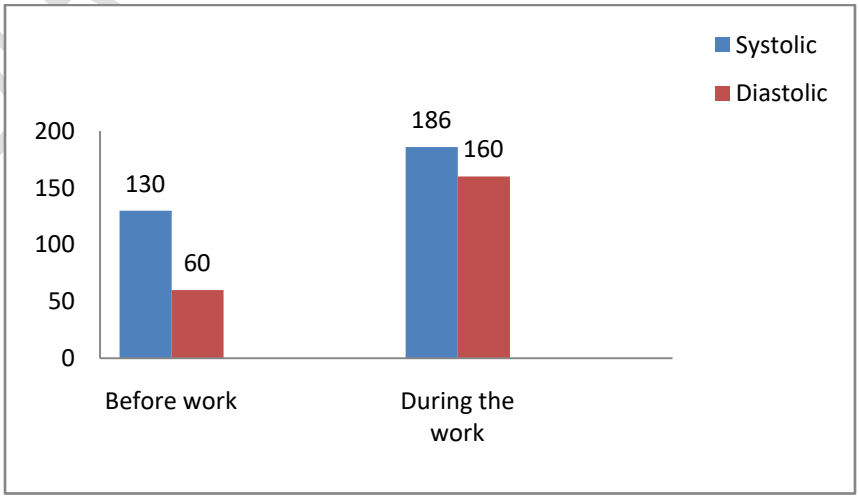

Figure 1 : Histogram illustrating the increase in blood pressure of the first

For the second worker, we have:

- **110 / 72** (before work)
- **118 / 80** (during work)

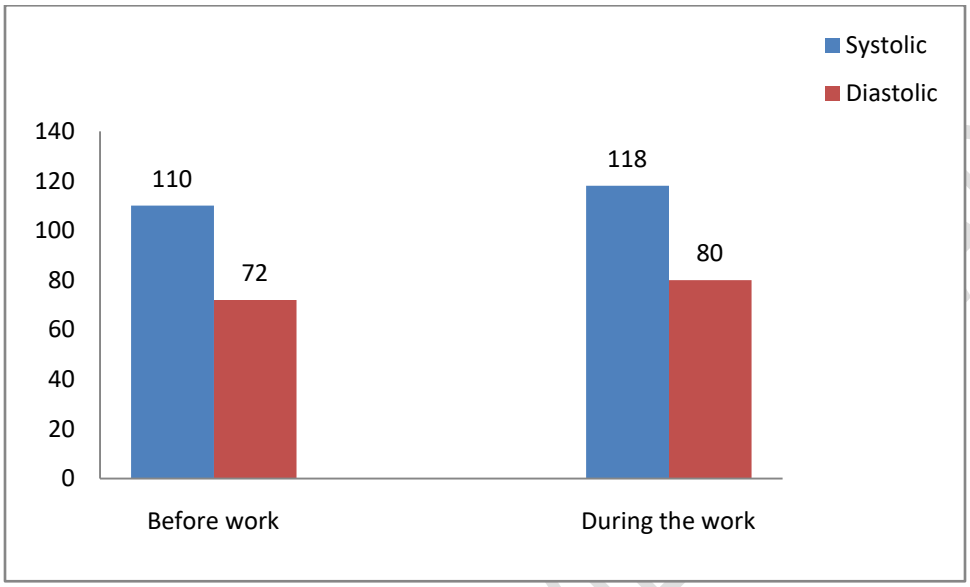

Figure 2: Histogram illustrating the increase in blood pressure on the 2nd worker

For the 3rd worker, we have:

- **114 / 70** (before work)
- **130 / 116** (during work)

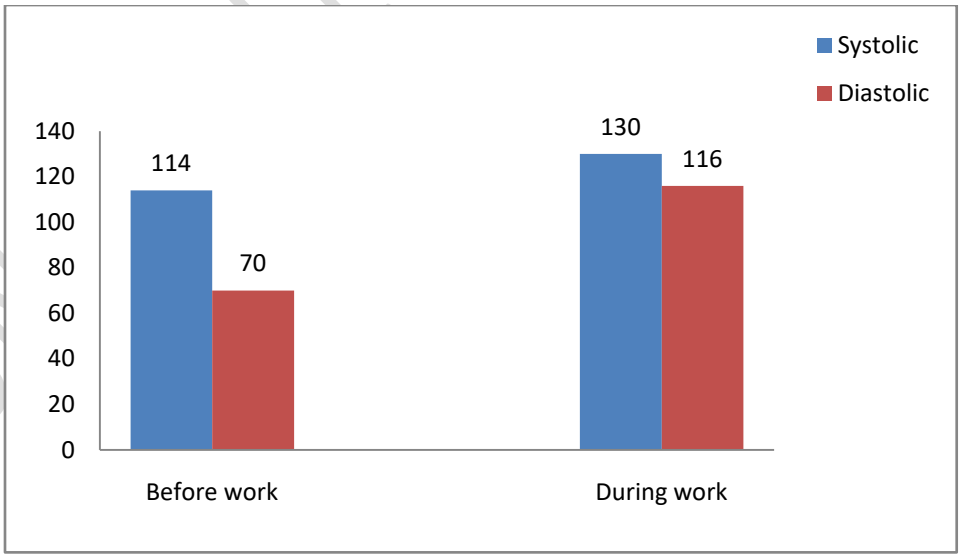

Figure 3: Histogram illustrating the increase in blood pressure on the 3rd worker

Analysis of the blood pressure measurements taken by the workers revealed that the blood pressure values measured during work were higher than those measured before noise exposure. This increase in blood pressure is attributed to the noise produced by the sawmill machinery. It can therefore be concluded that noise affects blood pressure. Furthermore, the blood pressures (**186/160**) and **(130/116)** measured during work for the **first** and **third** workers, respectively exceed the optimal blood pressure. Indeed, according to the article from the University Hospital of Lausanne (CHUV) entitled **"Blood Pressure: Measurement,"** dated February 26, 2019 **[** 10], the optimal blood pressure for an adult is less than **120 mmHg** when the heart contracts: **systolic pressure (SBP)** and **80 mmHg** when the heart relaxes: **diastolic pressure (DBP)** , i.e., **120/80.** This is called **arterial hypertension (HTN).** is considered when the **systolic pressure** is greater than or equal to **140 mmHg** and the **diastolic pressure** is greater than or equal to **90 mmHg,** i.e. **140 / 90.**

Regarding the measurement of noise levels, it appears that the **daily noise exposure level** of the BOSTONE SERVICE sawmill workers $\mathbf{L_{EX,8h}}$ **=84.8 dB(A)** exceeds **80 dB(A)** which East a threshold not to be exceeded in industrial settings according to ISO 9612:2009 [8] . The Noise Information and Documentation Centre (CidB) in France [11] and Decree No. $^{2022\text{-}301}$ of May 25, 2022 regulating noise in Benin [5] they also recommend that this threshold should not be exceeded.

In summary, it can be stated that the noise of machinery has an effect on the blood pressure of sawmill workers. Indeed, the noise triggers the release of the stress hormone **(**adrenaline**)**, which constricts blood vessels. and increases heart rate, blood pressure with a risk of hypertension **(**HTA**).**

Recommendations:-

To avoid high blood pressure among his workers , the owner of the BOSTONE SERVICE sawmill must use PICB **(** Personal Protection Against Noise **)** such as noise-canceling headphones and earplugs to protect them from the noise of the machines.

Conclusion:-

This research was conducted to demonstrate the effects of machine noise on the blood pressure of workers at the BOSTONE SERVICE sawmill located in Abomey-Calavi, Benin. To achieve

this objective, blood pressure measurements were taken using an automatic sphygmomanometer, and the equivalent continuous sound pressure level (Lp,A,eqT) and peak sound pressure level (Lp,C,peak) were measured using a calibrated class 1 integrating sound level meter with an accuracy of 0.7. The measured equivalent continuous sound pressure level (Lp,A,eqT) values were processed using software or a calculator from the French National Institute for Research and Safety (INRS) to obtain, firstly, the daily noise exposure level (L _{EX,8h}) of the workers at the BOSTONE SERVICE sawmill, and secondly, the expanded uncertainty **(U)** of the measurement. Analysis of the results clearly shows that machine noise affects the blood pressure of workers at the BOSTORNE SERVICE sawmill. To prevent high blood pressure, it has been recommended that workers at this sawmill wear personal hearing protection **(PHP)** such as earmuffs and earplugs to protect themselves from machine noise.

Acknowledgements:-

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