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Research Article

Assessment of Blood Pressure Variation Due to Noise Exposure Among Machine Operators Without Ear-protection at Workshops

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Abstract

Blood pressure variability (BPV) has been linked to cardiovascular diseases, including death and end-organ damage, according to several studies. Industrialization is typically linked to noise pollution, which can have negative health implications. Sounds in industries and workshops are classified as noise pollution when human activity exceeds the recommended threshold. The aim of the study is to determine blood pressure (BP) variation as a result of noise exposure among machine operators without ear protection at workshops, using an automatic arm BP monitor (model RAK269) with an accuracy of BP within ±3 mmHg. The longitudinal method was used for BP measurements of the operators before and after operating the industrial machine for two hours. The results showed that after using the machine, 44 operators between the ages of 20 and 29 had a mean BP elevation of 125.2/82.8 mmHg and a mean variability in their BP of 17.2/8.1 mmHg, which is in the prehypertensive range, with noise exposure level between 107.5 and 115.0 dBA. When exposed to noise pollution levels of 110.2–117.3 dBA, the 64 operators between the ages of 30 and 39 had a mean BP elevation of 129.7/84.8 mmHg and a BP variability of 20.4/9.0 mmHg, both of which are in the prehypertensive range. Furthermore, the 17 operators within the ages of 40 and 49 had a mean BP elevation of 135.5/86.6 mmHg, and their BP variation was recorded at 24.5/9.9 mmHg, which is also in the prehypertensive range when they are exposed to noise pollution that varies from 111.9 to 117.6 dBA. In conclusion, it has been confirmed that using an angle grinder or aluminium cutter without wearing ear protection directly affects the operators' SBP/DBP, raising their risk of developing cardiovascular diseases and other health issues associated with high noise exposure in workshop settings. In order to protect their health, operators must wear ear-protection and routinely monitor their blood pressure and hearing sensitivity, regulatory bodies to mandate the use of earplugs, earmuffs, and other ear protection at workshops.

Keywords

Blood Pressure Variability, Prehypertension, SBP/DBP, Noise Exposure, Pollution, Cardiovascular Diseases

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1. Introduction

Blood pressure variability (BPV) has been linked to mortality and end-organ damage [1-3], as well as cardiovascular events [4, 5]. The prognostic significance of long-term BPV has also drawn greater attention since recent data indicated that visit-to-visit variability measured over comparatively long intervals of follow-up has a higher prognostic value than average BP or BPV values over short follow-up periods [6, 7]. Arterial hypertension is a major risk factor for hearing damage, according to several clinical and experimental studies [8, 9]. According to Tan et al., patients with greater blood pressure had inferior pure-tone thresholds [10]. According to Bohne and Harding, the patterns of cochlear damage and their relationship to functional measures of hearing in chinchillas exposed to noise are comparable to those observed in humans exposed to noise, suggesting that prolonged exposure to high noise levels affects the cochlea [11].

Though the effects of hypertension on hearing have been extensively studied, the association between blood pressure variability and hearing impairment or capacity has not been previously examined. Noise pollution, which can have detrimental effects on health, is usually associated with industrialization. When human activity exceeds the suggested threshold, sounds produced in workplaces, such as workshops and industries, are categorized as noise. When the body's particles vibrate, its surrounding medium—such as the air—vibrates as well, creating a disturbance in the atmosphere. Understanding the fundamental ideas used to characterize sound is crucial to comprehending noise. Typically, there are two aspects of a sound: physical component which is the physics of sound creation, transmission, reception, and detection. Second, a person's sensory perception of sound influences their psychological and physiological responses.

The general well-being of workers is being impacted by occupational noise in numerous industries and workshops; this high noise level has both short- and long- consequences on the workers. High levels of noise pollution are recognized to pose serious health risks to both people and the environment. Diastolic blood pressure (DBP) is the lowest pressure in the large arteries during diastole, when the heart relaxes and fills with blood, with an average of less than 80 mmHg. Systolic blood pressure (SBP) is the highest pressure in the large arteries during systole, when the heart contracts, with an average value less than 120 mmHg.

According to Ologe, Akande, and Olajide, workers were subjected to noise levels ranging from 49 to 93 dBA and this have demonstrated that noise exposure is a contributing factor to the high prevalence of sensorineural hearing loss in their study sample [12]. Noise-induced hearing loss (NIHL) is caused by workers being exposed to noise levels that are harmful to their hearing mechanisms, and the noise dosage in the majority of work situations in businesses and industries are unknow [13]. There is mounting evidence that the pathophysiological link between blood pressure (BP) and unfavourable cardiovascular events may not be entirely explained by BP readings alone. Blood pressure variability (BPV), which is the degree of blood pressure variation over time, has been linked to cardiovascular disorders, according to post-hoc analysis of clinical trials and observational research [14-16].

A study revealed a harmful association between high occupational noise exposure and hypertension in young adults, and the study also suggested occupational noise exposure as a target for worksite interventions to prevent hypertension [17]. There is little research in determining the association between variation in blood pressure and exposure to high noise pollution in industries and workshops. Van Kempen et al., stated that noise exposure can contribute to the prevalence of cardiovascular disease; the evidence for a relation between noise exposure and ischemic heart disease is still inconclusive [18]. According to Bao et al., there is a substantial association between changes in DBP and hearing, and these results showed that hearing loss and an increase in long-term BPV were related [19]. Ogbo et al., stated that there is a strong link between extended exposure to high noise levels and an increase in cases of high blood pressure and irregular pulse rates among workers in the industries [20].

Blood pressure variations, often known as blood pressure variability (BPV), are a complex phenomenon. BPV has typically been considered a physiological sign reflecting autonomic nerve function and arterial compliance. Naturally, blood pressure fluctuates throughout the day and in response to environmental and lifestyle factors. To avoid long-term issues, it is important to monitor trends rather than individual measurements. Unusual or unpredictable patterns should be assessed by a healthcare provider [21]. Blood pressure variability refers to the systematic and non-systematic deviations in blood pressure readings between and within individuals. It is influenced by factors such as heart rate, respiration, and the sympathetic nervous system's responses. This variability can complicate the diagnosis and management of hypertension, as it may affect cardiovascular disease risk and the effectiveness of treatment strategies. [22]. The study's objective is to ascertain whether exposure to excessive noise levels by machine operators at workshops causes variations in blood pressure. There is no specific study that determines the variation in blood pressure of operators using angle grinders or aluminium cutter at metal and aluminium workshop.

2. Materials and Method

2.1. Materials

The materials utilized in the project's execution are: A Maxicom Digital Blood Pressure monitoring device (model RAK269) is a fully automatic model with an oscillographic, with a pressure range of 0~280 mmHg and an accuracy within ±3 mmHg. Handheld Garmin 73 GPS device. The angle grinder used are: Bosch angle grinder GWS 2000 9inch 2000W (Germany) and Smartec ST-2304 angle grinder 2200W, 230mm disc (China) while the aluminium/steel cutter used were Bosch mitre saw GCM254 D, 1800W (Germany), Rich-Plus mitre saw RP25516M, 1800W (China) and Max-Mech miter saw Max-92552A (China). Ear-muff (ANSI S3.19), Safety goggles and boots for personal protection and safety.

2.2. Method

Figure 1. *Digital Blood Pressure Monitoring Device.*

Figure 2. *Bosch GWS 2200 Professional angle grinder.*

Figure 3. *Bosch Cut-off machine and Mitre saw (GCM 254D).*

Data prospecting at metal and aluminium workshops was conducted using a longitudinal research method. Participants without earmuffs were divided into three age groups: 20–29, 30–39, and 40–49. According to the inclusive criteria used, blood pressure was only measured in operators between the ages of 20 and 49, who had been worked for at least two years. Operators who are on medication, worked for less than two years, were under twenty, or were above fifty because age-related hearing loss (ARHL) and, or engaged in morning exercise were excluded. The operators' blood pressure (SBP/DBP) measured and recorded using a digital blood pressure monitor while they were properly seated prior to turning on and using the angle grinder or the aluminium/steel cutter at each workshop. At the location where the operators operate, a smart digital sound level meter was used to monitor and record the sound pressure levels. Following using the machine for one to two hours and turning it off, the operators' SBP/DBP were measured and recorded at each workshop following a three-minute rest, taking note of the machine's specifications. To verify whether or not the measured SBP/DBP varied, this procedure was carried out twice more at each workshop with the same participants. This method was selected in order to ascertain whether the operators' blood pressure fluctuations are caused by high noise exposure. Within the study area, 125 metal and aluminium workshops participated in the study. Based on the age classifications of the participants, the data collected from the workshop locations were coded and structured in the letters A, B, C, D, and E, at each session. Below is the tabulation of the three-day mean SBP/DBP results. A digital blood pressure monitor is shown in Figure 1, Figure 2 shows a Bosch GWS 2200 Professional angle grinder and a Bosch Cut-off machine and Mitre saw (GCM 254D) is shown in Figure 3. The study area is located within Jos, Plateau State, Nigeria, with coordinates between latitude $9^o\,82' - 9^o\,90'$ North and longitude $9^o\,86' - 9^o\,90'$ East where there are many metals and aluminium workshops.

3. Results

The results are summarized into tables, as Table 1 shows the SBP/DBP variation for 44 operators without ear protection and working age 20 to 29 years. Table 2 shows the variation in SBP/DBP for 64 operators without ear protection and working ages 30 to 39 years. The SBP/DBP variation for 17 operators without ear protection and working age 40 to 49 years is shown in Table 3. The American Heart Association (AHA) blood pressure categories are shown in Table 4, while Table 5 shows the normal blood pressure by age charts by Medecin-net.com, formulated from the AHA. Table 6 shows the WHO classification of hypertension. The SBP/DBP elevation and variation were analysed and presented in figures as shown in Figure 4, which compared variation in SBP for operators without earmuffs and working age 20–29 years to AHA standards. Figure 5 shows the comparison in DBP variation for operators without earmuffs and working age 20–29 years to the AHA standard. The variation in SBP for operators without earmuffs and working age 30–39 years was compared to the AHA standard as shown in Figure 6. Figure 7 compared variation in DBP for operators without earmuffs and working age 30–39 years to AHA standards. The variation in SBP for operators without earmuffs and working age 40–49 years was compared to the AHA standard as shown in Figure 8. Figure 9 shows the comparison in DBP variation for operators without earmuffs and working age 40–49 years to the AHA standard.

Table 1. *Mean SBP/DBP Variation 44 Operators without Ear-protection and working age 20 to 29 years.*

s/n	W/S Code	SBP Before (mmHg)	SBP After (mmHg)	SBP Variation (mmHg)	DBP Before (mmHg)	DBP After (mmHg)	DBP Variation (mmHg)	Mean SPL dBA
1	A1	105.0	123.0	18.0	74.3	83.0	8.7	112.4
2	A2	108.0	123.0	15.0	74.0	83.3	9.3	113.0
3	A3	105.0	121.7	16.7	75.0	84.0	9.0	109.9
4	A4	105.7	125.0	19.3	76.0	83.0	7.0	113.3
5	A6	104.3	126.3	22.0	75.0	83.0	8.0	109.9
6	A7	105.3	123.3	18.0	74.0	82.7	8.7	109.0
7	A9	105.7	126.3	20.7	74.0	83.0	9.0	112.2
8	A11	108.0	125.0	17.0	73.0	85.3	12.3	112.4
9	A14	108.3	126.0	17.7	74.0	83.7	9.7	112.3
10	A16	109.3	125.3	16.0	73.3	83.0	9.7	111.3
11	A17	109.7	125.7	16.0	75.0	84.0	9.0	112.6
12	A23	109.7	125.3	15.7	74.3	83.7	9.3	113.4
13	A25	108.3	121.7	13.3	74.7	81.7	7.0	112.0
14	B1	109.3	123.0	13.7	74.3	82.0	7.7	114.1
15	B2	107.3	121.3	14.0	74.7	83.7	9.0	114.2
16	B8	106.7	122.7	16.0	74.0	82.7	8.7	109.7
17	B11	109.3	126.3	17.0	75.7	82.7	7.0	112.4
18	B12	109.0	124.3	15.3	74.0	81.7	7.7	111.9
19	B16	109.7	121.7	12.0	74.3	81.3	7.0	112.2
20	B17	109.0	126.3	17.3	75.3	83.0	7.7	112.2
21	B18	109.0	122.7	13.7	75.3	81.7	6.3	110.6
22	B19	108.7	122.7	14.0	76.3	81.7	5.3	115.0
23	B21	109.3	125.7	16.3	74.0	80.7	6.7	110.2
24	C23	109.3	127.0	17.7	76.7	85.3	8.7	112.4
25	D2	106.7	124.7	18.0	74.0	81.3	7.3	112.5
26	D6	107.0	124.7	17.7	75.0	84.7	9.7	110.1
27	D8	110.0	125.7	15.7	76.0	84.0	8.0	114.9
28	D14	107.0	126.3	19.3	74.3	81.3	7.0	111.7
29	D18	107.0	124.7	17.7	74.0	82.3	8.3	112.8
30	D20	107.0	126.3	19.3	74.0	83.3	9.3	112.0
31	D23	106.3	124.7	18.3	74.0	82.0	8.0	112.6
32	D24	108.0	124.3	16.3	74.3	80.3	6.0	112.0
33	E1	107.0	125.3	18.3	75.3	83.0	7.7	114.0
34	E3	106.7	125.3	18.7	74.7	83.0	8.3	113.4

s/n	W/S Code	SBP Before (mmHg)	SBP After (mmHg)	SBP Varia-tion (mmHg)	DBP Before (mmHg)	DBP After (mmHg)	DBP Varia-tion (mmHg)	Mean SPL dBA
35	E6	108.3	127.3	19.0	74.7	83.7	9.0	113.7
36	E9	109.7	128.3	18.7	75.3	83.7	8.3	114.3
37	E11	110.3	129.3	19.0	76.3	80.0	3.7	112.1
38	E12	108.7	126.3	17.7	74.7	82.0	7.3	114.0
39	E17	107.7	127.7	20.0	74.7	84.0	9.3	111.8
40	E19	109.3	127.7	18.3	74.3	82.7	8.3	110.9
41	E20	107.7	125.3	17.7	76.0	83.7	7.7	112.0
42	E22	108.0	126.7	18.7	74.3	81.3	7.0	112.3
43	E23	110.7	129.7	19.0	75.3	84.7	9.3	113.6
44	E25	108.3	127.3	19.0	75.0	84.3	9.3	107.5

Table 2. *Mean SBP/DBP Variation of 64 Operators without Ear-protection and working Ages 30 to 39 years.*

s/n	W/S Code	SBP Before (mmHg)	SBP After (mmHg)	SBP Variation (mmHg)	DBP Before (mmHg)	DBP After (mmHg)	DBP Variation (mmHg)	Mean SPL dBA
1	A5	108.7	130.3	21.7	77.3	85.7	8.3	111.0
2	A8	107.0	129.0	22.0	74.7	83.7	9.0	111.9
3	A10	108.0	132.7	24.7	74.7	85.0	10.3	115.2
4	A13	109.7	129.3	19.7	74.7	83.3	8.7	113.0
5	A19	109.7	132.0	22.3	76.0	86.7	10.7	114.5
6	A24	112.3	124.7	12.3	76.0	85.3	9.3	113.7
7	B3	112.0	130.7	18.7	75.0	84.0	9.0	113.6
8	B4	110.0	129.7	19.7	78.7	84.0	5.3	111.6
9	B5	108.7	127.7	19.0	77.0	84.0	7.0	112.7
10	B6	109.7	129.0	19.3	75.7	86.0	10.3	112.2
11	B7	111.3	126.7	15.3	76.7	85.0	8.3	110.6
12	B9	110.7	129.3	18.7	74.0	83.7	9.7	115.1
13	B10	110.3	130.7	20.3	74.7	83.0	8.3	111.1
14	B13	110.0	129.7	19.7	75.7	82.7	7.0	116.0
15	B14	109.7	134.3	24.7	75.0	87.0	12.0	114.5
16	B15	109.7	128.7	19.0	75.3	85.7	10.3	111.9
17	B20	110.7	127.0	16.3	75.3	82.7	7.3	115.5
18	B22	109.7	130.3	20.7	75.0	83.0	8.0	116.2
19	B23	111.7	129.7	18.0	74.7	84.7	10.0	116.1
20	B24	109.3	130.0	20.7	72.0	82.3	10.3	114.1
21	B25	110.3	127.7	17.3	74.0	81.7	7.7	112.8
22	C1	112.0	130.7	18.7	76.0	83.7	7.7	115.9
23	C3	105.3	126.7	21.3	75.3	85.7	10.3	111.0

s/n	W/S Code	SBP Before (mmHg)	SBP After (mmHg)	SBP Variation (mmHg)	DBP Before (mmHg)	DBP After (mmHg)	DBP Variation (mmHg)	Mean SPL dBA
24	C4	106.0	130.0	24.0	77.0	86.7	9.7	115.6
25	C5	107.7	127.7	20.0	76.7	86.3	9.7	110.6
26	C6	106.3	129.0	22.7	73.7	82.7	9.0	113.3
27	C7	108.3	130.0	21.7	77.3	86.0	8.7	111.5
28	C8	107.7	128.7	21.0	76.3	84.0	7.7	112.9
29	C9	107.7	130.3	22.7	75.7	85.7	10.0	112.5
30	C10	107.0	127.7	20.7	76.3	86.7	10.3	113.3
31	C11	107.0	130.7	23.7	73.7	85.3	11.7	113.8
32	C12	107.3	128.7	21.3	75.7	91.7	16.0	114.3
33	C13	106.0	127.7	21.7	75.3	86.0	10.7	112.5
34	C14	105.3	128.3	23.0	76.0	87.7	11.7	113.5
35	C15	106.7	126.7	20.0	73.0	84.3	11.3	112.2
36	C17	106.0	123.3	17.3	73.3	84.3	11.0	112.6
37	C18	108.3	128.0	19.7	77.7	87.3	9.7	112.6
38	C19	108.3	129.7	21.3	77.0	88.0	11.0	113.1
39	C20	109.0	127.0	18.0	75.7	83.7	8.0	111.6
40	C21	106.7	125.3	18.7	74.3	83.7	9.3	110.2
41	C22	106.0	125.3	19.3	74.7	82.3	7.7	111.1
42	C24	108.7	130.3	21.7	75.3	82.3	7.0	113.2
43	C25	108.7	127.3	18.7	76.3	84.0	7.7	111.9
44	D1	112.3	131.3	19.0	76.3	82.7	6.3	114.0
45	D3	111.3	132.0	20.7	77.0	83.7	6.7	111.9
46	D4	110.7	130.3	19.7	77.7	84.7	7.0	112.5
47	D5	110.3	131.3	21.0	76.7	85.3	8.7	113.4
48	D7	109.7	129.3	19.7	77.0	84.7	7.7	115.1
49	D9	110.7	131.3	20.7	75.7	85.0	9.3	115.8
50	D10	111.3	131.7	20.3	75.7	83.0	7.3	114.5
51	D12	111.0	129.3	18.3	76.0	84.0	8.0	113.7
52	D13	110.0	128.0	18.0	75.7	84.3	8.7	113.3
53	D15	108.7	128.3	19.7	76.7	83.0	6.3	115.0
54	D16	108.3	130.3	22.0	76.3	86.0	9.7	117.3
55	D17	112.0	134.0	22.0	75.0	83.0	8.0	113.0
56	D19	109.3	130.0	20.7	74.7	85.0	10.3	116.4
57	D21	110.7	132.3	21.7	76.7	85.0	8.3	115.4
58	E4	111.7	134.3	22.7	78.0	86.7	8.7	116.7
59	E5	109.3	131.7	22.3	77.3	85.7	8.3	115.7
60	E7	111.3	133.7	22.3	76.3	85.3	9.0	116.4
61	E10	112.0	133.0	21.0	76.3	85.0	8.7	115.3

s/n	W/S Code	SBP Before (mmHg)	SBP After (mmHg)	SBP Variation (mmHg)	DBP Before (mmHg)	DBP After (mmHg)	DBP Variation (mmHg)	Mean SPL dBA
62	E13	111.3	133.3	22.0	76.7	85.0	8.3	116.8
63	E14	108.7	131.3	22.7	75.7	85.3	9.7	113.5
64	E15	112.3	134.3	22.0	77.7	86.7	9.0	113.9

Table 3. *SBP/DBP Variation of 17 Operators without Ear-protection and working Age 40 to 49 years.*

s/n	W/S Code	SBP Before (mmHg)	SBP After (mmHg)	Variation SBP (mmHg)	DBP Before (mmHg)	DBP After (mmHg)	DBP Variation (mmHg)	Mean SPL dBA
1	A12	111.3	133.0	21.7	77.3	87.3	10.0	115.1
2	A15	108.3	132.3	24.0	77.0	87.7	10.7	113.0
3	A18	111.0	131.7	20.7	77.3	86.3	9.0	115.4
4	A20	110.7	133.0	22.3	77.0	87.0	10.0	114.0
5	A21	111.3	133.7	22.3	76.3	86.0	9.7	115.3
6	A22	110.3	131.0	20.7	77.3	87.0	9.7	112.7
7	C2	111.7	133.3	21.7	76.3	86.7	10.3	115.8
8	C16	108.0	132.0	24.0	75.7	87.3	11.7	111.9
9	D11	111.7	137.0	25.3	76.3	85.3	9.0	115.3
10	D22	111.7	139.3	27.7	77.7	87.7	10.0	117.6
11	D25	111.7	137.7	26.0	76.3	85.7	9.3	115.1
12	E2	112.3	139.3	27.0	75.7	85.3	9.7	117.1
13	E8	113.0	140.0	27.0	77.7	87.3	9.7	115.2
14	E16	110.0	138.7	28.7	77.7	86.3	8.7	117.5
15	E18	111.3	138.0	26.7	75.7	85.7	10.0	113.1
16	E21	112.0	139.0	27.0	77.3	86.7	9.3	117.2
17	E24	110.0	134.7	24.7	75.7	87.7	12.0	117.0

Table 4. *American Heart Association (AHA) Blood Pressure Categories.*

BLOOD PRESSURE CATEGORIES	Systolic mmHg (Upper number)		Diastolic mmHg (Lower number)
Normal	Less than 120	And	Less than 80
Elevated	120 - 129	And	Less than 80
High Blood Pressure (Hypertension) Stage 1	130 - 139	Or	80 - 89
High Blood Pressure (Hypertension) Stage 2	140 or Higher	Or	90 or Higher
Hypertension crisis (Consult Doctor immediately)	Higher than 180	And/Or	Higher than 120

Source: https://www.heart.org/en/health-topics/high-blood-pressure/

Table 5. Normal Blood Pressure by Age Charts.

Age	Systolic (mmHg)		Diastolic (mmHg)	
	Minimum	Maximum	Minimum	Maximum
20–29 years	~110	~120	~70	~80
30–39 years	~115	~125	~75	~80
40–49 years	~120	~130	~80	~85
50–59 years	~125	~135	~80	~85
60–69 years	~130	~140	~80	~85
70+ years	~135	~145	~80	~85

Source: [23] https://www.medicinenet.com/ (Medically Reviewed on 12/5/2024)

Table 6. Classification of Hypertension.

Blood Pressure Classification	Systolic Blood Pressure [SBP] (mmHg)	Diastolic Blood Pressure [DBP] (mmHg)	Colour Indicator
Optimal	< 120	< 80	Green
Normal	120 – 129	80 – 84	Green
High- Normal	130 – 139	85 – 89	Green
Grade 1 Hypertension	140 – 159	90 – 99	Yellow
Grade 2 Hypertension	160 – 179	100 – 109	Yellow
Grade 3 Hypertension	≥ 180	≥ 110	Red

Source:[24] WHO/ISH definition and classification of Blood pressure level (2021)

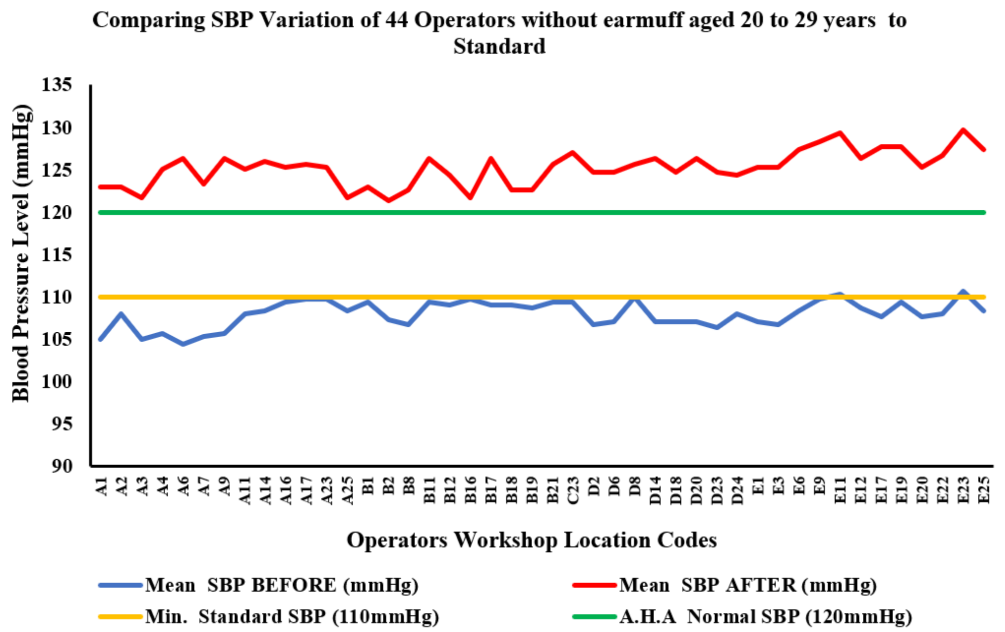

Figure 4. Comparing variation in SBP for Operators Without e\Earmuff and Working age 20–29 years to A.H.A standard.

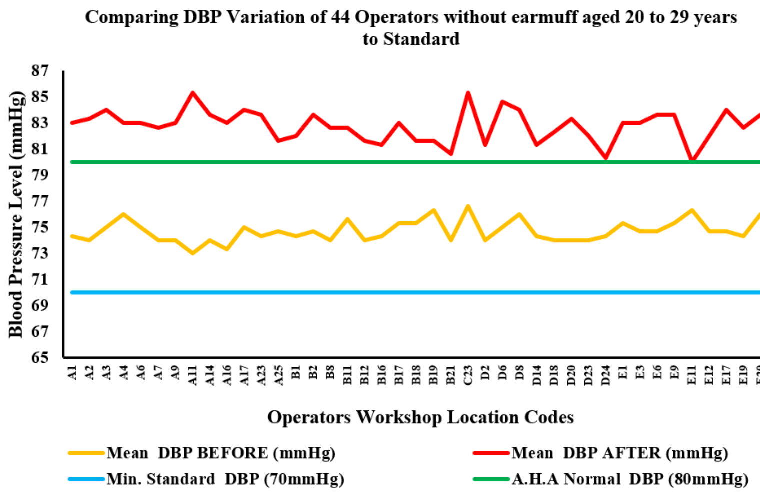

Figure 5. Comparing variation in DBP for Operators Without Earmuff and Working age 20–29 years to A.H.A standard.

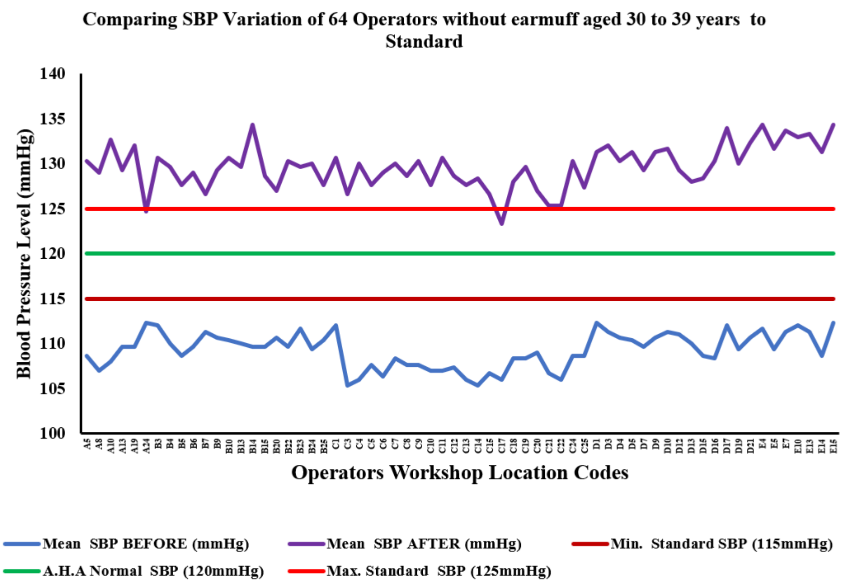

Figure 6. Comparing variation in SBP for Operators Without Earmuff and working age 30–39 years to A.H.A standard.

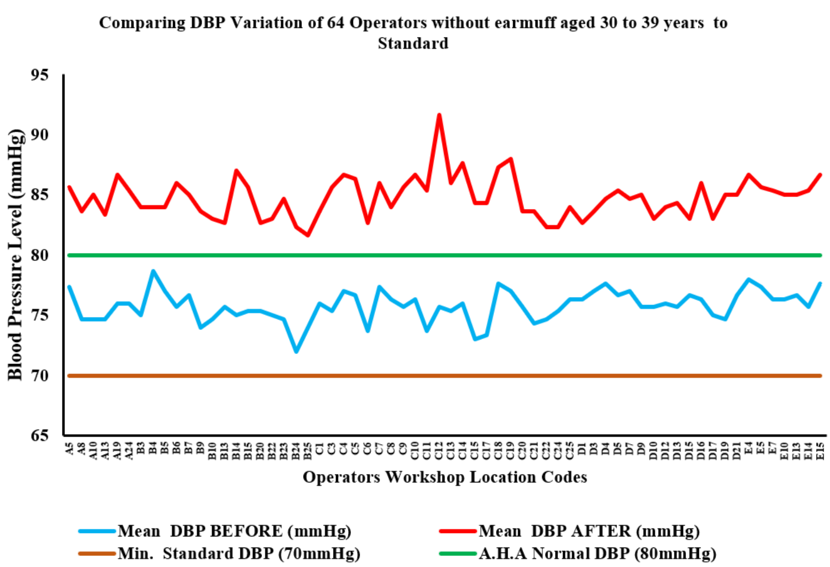

Figure 7. Comparing variation in DBP for Operators Without Earmuff and working age 30–39 years to A.H.A standard.

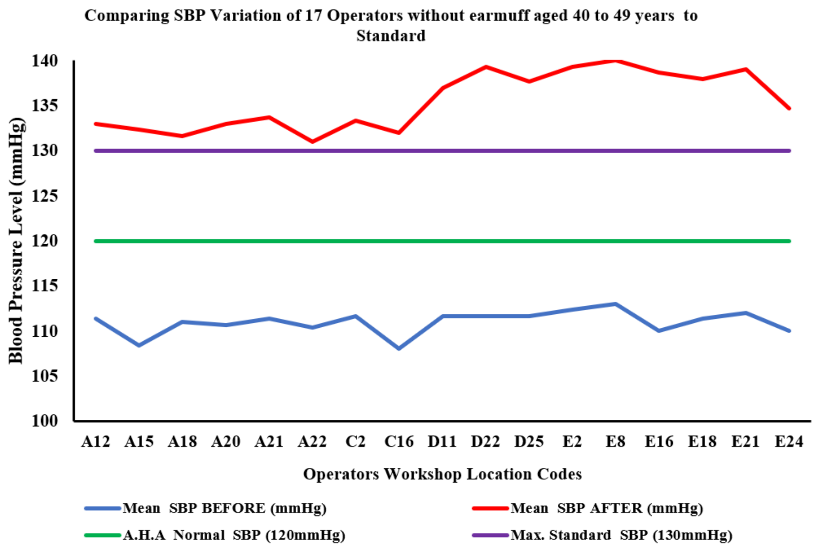

Figure 8. *Comparing variation in SBP for Operators Without Earmuff and Working age 40–49 years to A.H.A standard.*

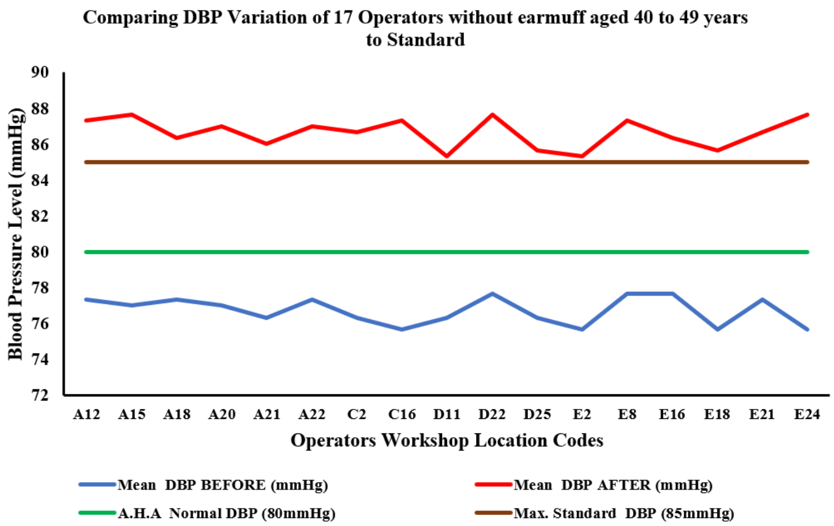

Figure 9. *Comparing variation in DBP for Operators Without Earmuff and working age 40–49 years to A.H.A standard.*

4. Discussions

The total number of operators without ear protection was 125, of which 35% are age 20 – 29, 51% age 30 – 39, and 14% age 40 – 49. From Figure 4, the SBP after operating the industrial machine shows an elevation in SBP above the AHA normal value of 120 mmHg; the group has an SBP range of 121.3 to 129.7 mmHg, a mean of 125.2 mmHg, and a mean variation of 17.2 mmHg after exposure to a noise level of 112.3 dBA. It was observed in Figure 5 that all 44 operators had DBP elevation above 80 mmHg, the normal and maximum value for the age group. Also, for Figure 5, 2 operators had DBP ≤ 80 mmHg, while 42 had DBP greater than 80 mmHg; the DBP ranged from 80.0 to 85.3 mmHg, with a mean DBP elevation of 82.8 mmHg and a mean variation of 8.1 mmHg. This rise in SBP/DBP after operating the machine was a result of exposure to noise level range 107.5 to 115.0 dBA by the operators without ear protection when using the machine. This variability in SBP/DBP for 44 operators aged 20–29 years was consistent with previous research results, which reported a variability in SBP/DBP as a result of exposure to high noise pollution for industrial workers. Furthermore, Figure 6 shows all 64 operators had SBP above the A.H.A. normal value of 120 mmHg; when compared to the maximum SBP for the age group, it was observed that 4 operators had SBP ≤ 125 mmHg, while 60 had SBP greater than 125 mmHg. The SBP ranges from 123.3 to 134.3 mmHg, with a mean SBP elevation of 129.7 and a mean variation of 20.4 mmHg. Additionally, Figure 7 shows the DBP of the same operators; it shows the DBP after being above the 80 mmHg AHA standard with a mean elevation of 84.8 mmHg, a mean variation of 9.0 mmHg, and

DBP ranging from 81.7 to 84.8 mmHg. This variation was associated with the exposure to the noise level range of 110.2 to 117.3 dBA without ear protection when operating the machine. This variability in SBP/DBP for 64 operators was consistent with previous research results, which reported a variation in SBP/DBP as a result of exposure to high noise pollution in some work environments.

In addition, Figure 8 shows 17 operators aged 40 – 49 years had a mean SBP elevation of 135.5 mmHg and a mean variation of 24.5 mmHg; it was observed that all 17 operators had a normal above 120 mmHg and a maximum of 130 for the age group, with values ranging from 131.0 to 140 mmHg. Also, Figure 9 showed a DBP for the same group with a mean DBP elevation of 86.6 mmHg, a mean DBP variation of 9.9 mmHg, and DBP ranging from 85.3 to 87.7 mmHg; hence, all 17 operators had DBP above the AHA normal value of 80 mmHg, while 2 operators had DBP ≤ 85 mmHg and 15 operators had values above 85 mmHg. This variation was associated with the exposure to noise level range 111.9 to 117.6 dBA without ear protection when operating the machine. This variability in SBP/DBP for 17 operators was consistent with previous research results, which reported a variation in SBP/DBP as a result of exposure to high noise pollution in some work environments.

5. Conclusion

Based on the findings, 44 operators aged 20 to 29 years showed a mean BP elevation of 125.2/82.8 mmHg and a variability in their BP of 17.2/8.1 mmHg, which is in the prehypertensive range after using the machine for two hours without era protection, with noise exposure levels between 107.5 and 115.0 dBA. Among the 64 operators aged 30 to 39 years, there was a mean BP elevation of 129.7/84.8 mmHg, and their BP variability was recorded at 20.4/9.0 mmHg, which is also in the prehypertensive range when exposed to noise levels of 110.2–117.3 dBA without ear protection. Additionally, the 17 operators aged 40 to 49 years had a mean BP elevation of 135.5/86.6 mmHg, and their BP variability was recorded at 24.5/9.9 mmHg, which is also in the prehypertensive range encountering noise pollution ranging from 111.9 to 117.6 dBA. Therefore, in conclusion, using an angle grinder or aluminium cutter in a workshop without ear protection has been observed to directly impact the operators' SBP/DBP of industrial machine operators, thereby elevating their chances of developing cardiovascular diseases and other health issues linked to high noise exposure levels in workshop environments. Other adverse effects of high noise exposure are noise-induced hearing loss (NIHL), headache, stress, anxiety, difficulty communicating, sleeping disorders, etc.

6. Recommendation

Therefore, there is a need for machine operators to use ear protection and other personal protective equipment (PPE) to safeguard their health and regularly check their blood pressure level. Also, regulatory agencies should enforce the use of ear protection, such as earmuffs, earplugs, etc., at workshops to reduce the effects of exposure to noise pollution. Operators are advised to regularly check their blood pressure and hearing sensitivity because they are highly at risk because of the nature of their work.

Abbreviations

AHA	American Heart Association
ARHL	Age Related Hearing Loss
BP	Blood Pressure
BPV	Blood Pressure Variability
dBA	Decibel A- weighting
DBP	Diastolic Blood Pressure
NIHL	Noise Induced Hearing Loss
PPE	Personal Proactive Equipment
SBP	Systolic Blood Pressure
WHO	World Heart Organization

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Conflicts of Interest

The authors declare no conflicts of interest.

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