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The Impact of Earmuff use in relation to Blood Pressure Due to Noise Exposure Among Machine Operators at Workshops

EDWIN FRANCIS ABOCHE*[1], EZEKIEL KUARA MAKAMA[2], OLADELE FRANCIS ANJORIN[3], NESTOR MONDAY DANGU CHAGOK[4]
[1]*Pure & Applied Physics, Federal University Wukari, Taraba State, Nigeria.*
[2, 3, 4]*Physics Department, University of Jos, Plateau State, Nigeria.*
0000-0002-7879-3034 *(Edwin Francis Aboche)*
0000-0001-7074-0037 *(Ezekiel Kuara Makama)*

Abstract—Earmuffs and earplugs are hearing protection devices that play a significant role in shielding industrial workers from noise exposure; these devices must be placed correctly to guarantee that the entire ear canal is closed. The majority of industrial machine operators at metal and aluminium fabrication workshops complained that they don't use ear protection because it interferes with communication with other workers. The aim of this study is to evaluate the effect of noise exposure in workshops on the blood pressure of machine operators wearing earmuffs. A digital blood pressure monitoring device was used to measure the SBP/DBP of 125 earmuff-wearing industrial machine operators, ages 20 to 49, both before and after they used the machine for at least two hours each day for three days. The findings revealed that when exposed to a noise level of 112.4 dBA, operators between the ages of 20 and 29 had an SBP/DBP increase of 8/5 mmHg, a negligible correlation of 0.323 for SPL/SBP and 0.1906 for SPL/DBP. When subjected to a noise level of 112.7 dBA, the operators, who were between the ages of 30 and 39, exhibited an insignificant correlation of 0.119 for SPL/SBP and 0.006 for SPL/DBP, with an elevation of 8/5 mmHg. When exposed to noise level of 113.9 dBA, the operators between the ages of 40 and 49 had an SBP/DBP increase of 10/6 mmHg, a weak correlation of 0.271 for SPL/SBP and 0.129 for SPL/DBP. The study concluded that there was a negligible correlation between the operators' SBP/DBP variation and the noise level they encountered when operating an industrial machine and wearing an earmuff. Additionally, for an operator wearing an earmuff, the BP elevation demonstrated a minimal elevation in SBP/DBP; therefore, the noise exposure had little to no impact on the operator's blood pressure.

Keywords— blood pressure, correlation, earmuff, sbp/dbp variation, noise level, noise exposure.

I. INTRODUCTION

Excessive noise exposure in factories and workshops is a major problem, especially in developing nations. The loud production equipment used in the workshops causes hearing impairment for many manufacturing workers in developing countries like Nigeria. Occupational weariness is also one of the physiological and psychological issues that are regularly complained about by textile workers because of exposure to noise from weaving machines [1, 2]. When human activity surpasses the recommended threshold, sounds produced in workplaces, such as workshops and industries, are categorised as noise. In many industries and workplaces, occupational noise has an adverse effect on workers' general health; workers who do not wear earmuffs or personal protective equipment are impacted both instantly and over time by this high noise level. Noise exposure at work can be minimised by implementing engineering solutions, including the installation of soundproof booths, acoustic treatments, and administrative strategies. These include limiting the length of time employees spend in noisy environments or switching them between locations with different noise levels.

Hearing protection devices are the last choice in the hierarchy of noise management since they may make working uncomfortable [3]. This is accurate since the majority of industrial machine operators in metal and aluminium fabrication workplaces have complained that they don't wear ear protection because it interferes with their ability to communicate with co-workers. According to research, wearing earmuffs and Ongoing Professional Practice Evaluation (OPPE) simultaneously has an impact on the sound pressure level (SPL) beneath the earmuffs. The design of OPPE used in conjunction with earmuffs affects the SPL values reached. It is clear that different earmuff models result in different SPL variations caused by the usage of OPPE. The negative

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effects of OPPE on the effectiveness of hearing protection can be mitigated when earmuffs and OPPE are used in combination [4]. Earmuffs and earplugs are hearing protection equipment that play a significant role in shielding industrial workers from noise exposure. In order to protect the ears and reduce irritation, these devices must be placed correctly to guarantee that the entire ear canal is closed [5]. To increase adherence to their use, companies and industries must offer hearing protection equipment and hold frequent training sessions [6]. Additionally, it is crucial for industry supervisors to keep monitoring employees' use of hearing protection devices in order to enhance workplace discipline [7]. Noise-induced hearing loss (NIHL) occurs when employees are exposed to noise levels that are harmful to their hearing mechanisms without wearing earmuffs or earplugs. Despite a large body of research on noise induced hearing loss (NIHL) in industry and workshop, prior publications have frequently been methodologically constrained, concentrating on the immediate impact on hearing using cross-sectional designs rather than examining changes over time [8].

According to a study, earmuffs intended to shield workers from the damaging effects of noise increase generally accepted levels of weariness and impaired hearing [9]. Workers' health is negatively impacted by excessive noise exposure, particularly in terms of the physiological and psychological effects [10]. Depending on the amount and length of exposure, the effects of extreme noise exposure might range from temporary to permanent loss [11]. Wearing hearing protection can lessen an employee's exposure to loud noises, according to several studies. On the other hand, nothing is known about hearing protection that can considerably lessen issues related to either temporary or permanent loss [12]. Noise levels above the threshold have also been linked to occupational tiredness, according to several studies. Chung et al. found that using OPPE reduced earmuff attenuation by up to 9 dB, as did a study using a single earmuff model [13]. Manufacturers specify the sound attenuation of hearing protectors in the user manual. The efficiency of protection under actual conditions frequently differs from the assumed effectiveness of hearing protection resulting from the usage of hearing protectors based on the sound attenuation levels stated in the user manual [14, 15]. These discrepancies are caused by the fact that tests to ascertain the sound attenuation of hearing protectors are carried out on brand-new samples of hearing protectors in controlled laboratory settings, often by a group of trained volunteers [16, 17].

Diastolic blood pressure (DBP) is the lowest pressure in the main arteries during diastole, when the heart relaxes and fills with blood. It is often less than 80 mmHg. Systolic blood pressure (SBP) is the highest pressure in the major arteries during systole, when the heart contracts, and it is typically less than 120 mmHg. Blood pressure variability (BPV), or the degree of blood pressure variation over time, has been linked to cardiovascular diseases, according to post hoc analysis of clinical trials and observational research [18, 19, 20]. Blood pressure naturally changes throughout the day and in reaction to environmental and lifestyle variables. Preventing long-term issues requires keeping track of patterns rather than specific actions. Any unusual or unexpected patterns should be assessed by a medical professional [21]. Blood pressure variability is the term used to describe the systematic and non-systematic differences in blood pressure readings between and within individuals. It is influenced by a number of factors, including respiration, heart rate, and the sympathetic nervous system. This variability can make identifying and managing hypertension more challenging because it may affect the risk of cardiovascular disease and the effectiveness of treatment options [22]. However, it has been found that using an angle grinder or aluminium cutter in a workshop without ear protection directly affects the SBP/DBP of industrial machine operators, increasing their risk of cardiovascular diseases and other health problems associated with high noise exposure levels in workshop environments [23].

Furthermore, little research has been done on how earmuffs affect industrial machine workers' blood pressure variations and hearing impairment. A focused effort that assesses the effectiveness of earmuff protection in lowering hearing issues among machine operators at metal and aluminium workshops as well as any effects on blood pressure (systolic or diastolic) is necessary to close this knowledge gap. Future research may therefore offer suitable suggestions for ear protection techniques targeted at metal and aluminium fabrication workshops, enhancing worker occupational health outcomes. The process of choosing hearing protectors involves determining the A-weighted sound level beneath them using the workplace's noise

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characteristics and the hearing protectors' sound attenuation [24]. In certain cases, wearing hearing protection is the only way to lessen workers' exposure to noise. Complete hearing protection is only possible with carefully chosen and used hearing aids. The aim of this study is to assess the impact of noise exposure in workshops on the blood pressure of machine operators wearing earmuffs. While several studies have looked at how earmuffs reduce noise, comparatively few have looked at how earmuff use impacts people's general well-being. This study relates changes in blood pressure to industrial machine operators' use of earmuffs.

II. MATERIALS AND METHOD

A. *Instruments and equipment*

The following are the specifications of the instruments and equipment adopted in the research process: The Maxicom Digital Blood Pressure Monitor (model RAK269) is an oscillographic, completely automatic instrument with a pressure range of 0~280 mmHg and an accuracy of ±3 mmHg and a portable Garmin 73 GPS unit. The angle grinder commonly used at the workshops are: Bosch angle grinder GWS 2000 9inch 2000W (Germany) and Smartec ST-2304 angle grinder 2200W, 230mm disc (China) while the commonly used aluminium/steel cutter used were Bosch mitre saw GCM254 D, 1800W (Germany), Rich-Plus mitre saw RP25516M, 1800W (China) and Max-Mech mitre saw Max-92552A (China). An Ear-muff with Noise reduction rating between 20dBA to 35dBA and plastic material with equivalent standards of ANSIS3.19, Safety goggles and boots for personal protection and safety. A Sound Level Meter (SLM) with Range from 30dBA to 130dBA with frequency weighting of (dBA), accuracy of ±1.5dBA, Resolution of 0.1dBA, and a slow or fast response time.

B. *Method*

There are 125 operators with earmuffs that used standard angle grinders or aluminium cut-off and mitre saws at the workshop participated in this study and adopted a longitudinal study approach to prospect data at metal and aluminium workshops. Three age groups comprised the earmuff-wearing participants: 20–29, 30–39, and 40–49. Only operators between the ages of 20 and 49 who had been working for at least two years had their blood pressure measured in accordance with the included criteria. Operators who took medicine, had been employed for less than two years, were younger than twenty, or were older than fifty due to age-related hearing loss (ARHL) and/or exercised in the morning were not included. Before turning on and operating the angle grinder or the aluminium/steel cutter while wearing an earmuff at each workplace, the operator's blood pressure (SBP/DBP) was measured and recorded using a digital blood pressure monitor while they were appropriately seated. A smart digital sound level meter was used to monitor and record the sound pressure levels at the workshop where the operators operate the machine while wearing earmuffs. Following a three-minute rest, the operators' SBP/DBP was measured and recorded at each workshop after using an angle grinder or aluminium cut-off mitre saw machine for one to two hours and turning it off. The machine's details were noted.

This process was repeated again at each workshop with the same participants on separate days in order to confirm whether or not the measured SBP/DBP altered. This approach was chosen to determine whether high noise exposure is the cause of the operators' blood pressure variation. 125 operators with earmuff-equipped at metal and aluminium workshops in the research area took part. At each session, the data gathered from the workshop sites was classified and organised using the letters A, B, C, D, and E based on the participants' age categories.

The map of the metal and aluminium workshops in the research region is displayed in Figure 1. Figure 2 shows a digital blood pressure monitor. The following are typical industrial equipment used in the workshops, as seen in Figure 3: a Bosch mitre saw and cut-off machine (GCM 254D). Figure 4: Bosch GWS 2200 professional angle grinder, and Figure 5 displays the sound level meter (HA:2451980), and Figure 6 depicts the operator's earmuff (ANSI S3.19).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.

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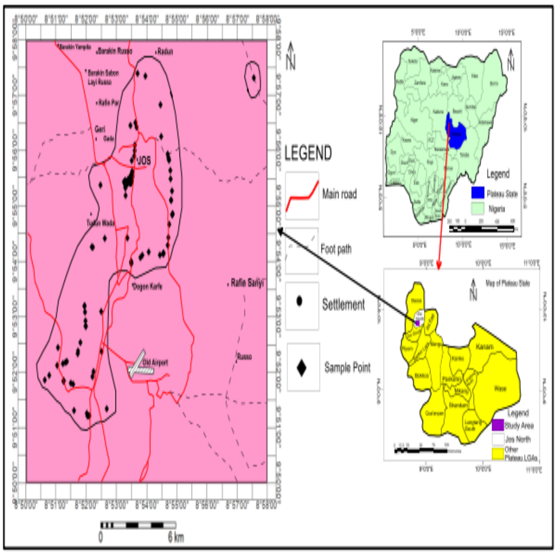

Figure 1. Map of the Metal/Aluminium workshops location in the study area

Figure 2. Digital Blood Pressure Monitoring Device

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

Figure 4. Bosch GWS 2200 Professional angle grinder

Figures 5. Sound Level Meter (HA:2451980)

Figure 6. An Ear-Muff (ANSI S3.19)

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III. RESULTS

The results are summarized into tables, as Table 1 shows the SBP/DBP variation for 44 operators with ear muff and working age 20 to 29 years. Table 2 shows the variation in SBP/DBP for 64 operators with ear muff and working ages 30 to 39 years. The SBP/DBP variation for 17 operators with ear muff 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 Medecinnet.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 7, which compared variation in SBP for operators with earmuffs and working age 20–29 years to AHA standards. Figure 8 shows the comparison in DBP variation for the same operators with earmuffs and working age 20–29 years to the AHA standard. The variation in SBP for operators with earmuffs and working age 30–39 years was compared to the AHA standard as shown in Figure 9. Figure 10 compared variation in DBP for operators with earmuffs and working age 30–39 years to AHA standards. The variation in SBP for operators with earmuffs and working age 40–49 years was compared to the AHA standard as shown in Figure 11. Figure 12 shows the comparison in DBP variation for operators with earmuffs and working age 40–49 years to the AHA standard.

Table 1. Mean SBP/DBP Elevation of Operators WITH Ear-Muff (E) and working 20 to 29 years

s/n	W/S CODE	Mean SBP Before (mmHg)	Mean SBP After (mmHg)	SBP Elevation (mmHg)	Mean DBP Before (mmHg)	Mean DBP After (mmHg)	DBP Elevation (mmHg)	Mean SPL (dBA)
1	A1-E	106	113	7	74	79	5	111.9
2	A2-E	109	115	6	75	77	2	113.9
3	A3-E	107	113	6	73	79	5	106.8
4	A4-E	107	115	8	74	79	5	111.9
5	A6-E	108	115	7	74	78	5	108.3
6	A7-E	107	115	8	75	80	5	108.7
7	A9-E	109	116	7	73	78	5	111.8
8	A11-E	108	115	7	75	79	5	113.0
9	A14-E	110	116	7	75	81	5	114.6
10	A16-E	107	115	8	74	79	4	111.9
11	A17-E	107	115	8	75	80	5	111.8
12	A23-E	110	115	5	74	79	5	114.5
13	A25-E	109	116	7	74	80	6	113.2
14	B1-E	109	116	7	74	79	4	113.4
15	B2-E	108	115	7	75	80	4	112.7
16	B8-E	110	118	8	76	81	5	111.4
17	B11-E	109	116	7	75	79	4	111.1
18	B12-E	107	115	7	74	79	6	110.3
19	B16-E	108	116	7	74	79	5	112.7
20	B17-E	109	113	4	75	79	4	110.4
21	B18-E	109	117	8	75	80	5	110.6
22	B19-E	108	116	8	74	79	5	114.5
23	B21-E	108	116	8	75	79	5	108.5
24	C23-E	109	117	8	76	80	4	112.4

25	D2-E	107	115	8	74	79	5	111.4
26	D6-E	108	117	9	75	80	5	110.4
27	D8-E	109	116	8	76	81	5	115.3
28	D14-E	107	117	9	75	80	5	112.0
29	D18-E	108	116	9	74	79	5	113.4
30	D20-E	108	116	8	75	79	5	112.4
31	D23-E	108	117	9	74	80	5	112.5
32	D24-E	109	117	8	75	79	5	111.1
33	E1-E	109	116	7	76	81	6	114.6
34	E3-E	108	116	7	73	78	5	115.9
35	E6-E	108	116	8	74	80	6	114.7
36	E9-E	108	117	9	74	79	5	113.5
37	E11-E	108	117	9	76	81	5	116.3
38	E12-E	109	116	7	75	80	5	114.8
39	E17-E	108	115	7	74	79	5	113.8
40	E19-E	112	119	6	74	79	5	116.4
41	E20-E	107	116	9	74	79	5	112.7
42	E22-E	108	116	8	74	78	4	116.3
43	E23-E	109	117	8	73	79	6	108.6
44	E25-E	109	116	8	74	79	5	107.5

Table 2: Mean SBP/DBP Elevation of Operators WITH Ear-Muff (E) and working 30 to 39 years

s/n	W/S CODE	Mean SBP Before (mmHg)	Mean SBP After (mmHg)	SBP Elevation (mmHg)	Mean DBP Before (mmHg)	Mean DBP After (mmHg)	DBP Elevation (mmHg)	Mean SPL (dBA)
1	A5-E	110	116	6	76	81	5	110.5
2	A8-E	110	120	9	76	81	5	111.4
3	A10-E	111	119	8	76	81	5	114.1
4	A13-E	110	118	8	76	80	5	113.2
5	A19-E	110	119	9	76	80	4	113.6
6	A24-E	110	117	7	74	79	5	113.1
7	B3-E	109	117	8	76	81	5	111.6
8	B4-E	112	119	7	76	80	4	110.7
9	B5-E	109	118	9	75	80	5	111.3
10	B6-E	111	120	9	76	81	5	113.1
11	B7-E	110	119	9	75	80	5	110.8
12	B9-E	111	118	7	75	80	5	113.4
13	B10-E	110	117	7	76	81	5	111.8
14	B13-E	110	117	7	75	80	6	113.3
15	B14-E	112	120	7	77	82	5	112.2
16	B15-E	109	118	9	75	80	5	112.9
17	B20-E	110	118	9	75	79	5	114.0

18	B22-E	111	120	9	77	82	5	114.0
19	B23-E	111	118	7	74	80	6	114.2
20	B24-E	111	119	8	77	82	5	112.4
21	B25-E	110	119	9	76	80	4	111.5
22	C1-E	110	119	9	76	80	5	113.1
23	C3-E	111	120	9	74	78	5	113.3
24	C4-E	110	121	10	77	83	6	113.1
25	C5-E	111	119	8	76	82	6	110.8
26	C6-E	110	117	7	76	81	5	111.4
27	C7-E	109	117	8	74	79	5	111.4
28	C8-E	109	119	10	74	79	5	112.3
29	C9-E	111	123	12	75	80	5	110.0
30	C10-E	110	117	7	74	79	5	111.4
31	C11-E	111	121	10	75	80	5	112.3
32	C12-E	109	118	8	76	81	5	113.2
33	C13-E	111	119	9	74	79	5	112.8
34	C14-E	111	119	8	76	81	5	113.2
35	C15-E	109	119	10	74	79	5	111.4
36	C17-E	110	118	8	76	81	5	112.3
37	C18-E	109	118	9	74	79	5	113.1
38	C19-E	109	120	11	74	79	5	112.7
39	C20-E	111	119	9	74	80	5	110.0
40	C21-E	111	118	8	74	79	5	111.1
41	C22-E	109	118	9	75	80	5	110.9
42	C24-E	110	117	7	75	80	5	111.4
43	C25-E	111	119	9	77	83	5	112.3
44	D1-E	112	120	8	75	80	5	114.0
45	D3-E	111	120	9	76	81	5	110.5
46	D4-E	111	120	8	77	82	6	113.9
47	D5-E	110	119	9	77	82	5	111.0
48	D7-E	111	118	7	76	81	5	113.8
49	D9-E	111	120	10	76	81	5	113.4
50	D10-E	110	118	8	76	80	5	111.8
51	D12-E	111	120	9	75	81	5	114.1
52	D13-E	110	117	7	74	80	6	114.5
53	D15-E	110	120	9	74	80	5	115.8
54	D16-E	111	120	9	75	80	5	115.4
55	D17-E	109	119	9	75	80	5	110.9
56	D19-E	111	119	8	76	81	6	113.7
57	D21-E	110	119	9	75	81	5	114.5
58	E4-E	112	119	7	75	80	5	113.7
59	E5-E	110	117	7	74	79	5	115.4

60	E7-E	110	119	9	76	81	5	115.4
61	E10-E	111	119	8	75	80	5	111.6
62	E13-E	110	119	8	76	81	5	113.9
63	E14-E	111	120	9	75	80	5	116.4
64	E15-E	112	118	6	75	79	5	111.8

Table 3: Mean SBP/DBP Elevation of Operators WITH Ear-Muff (E) and working 40 to 49 years

s/n	W/S CODE	Mean SBP Before (mmHg)	Mean SBP After (mmHg)	SBP Elevation (mmHg)	Mean DBP Before (mmHg)	Mean DBP After (mmHg)	DBP Elevation (mmHg)	Mean SPL (dBA)
1	A12-E	112	123	11	77	83	6	113.4
2	A15-E	111	121	10	77	83	5	112.0
3	A18-E	112	120	8	77	83	6	113.8
4	A20-E	111	121	10	77	84	6	112.7
5	A21-E	111	122	11	78	83	6	114.6
6	A22-E	110	122	12	78	83	5	112.2
7	C2-E	113	123	10	76	84	5	115.6
8	C16-E	112	123	11	77	83	3	112.7
9	D11-E	112	123	11	77	82	5	115.7
10	D22-E	112	121	9	77	83	6	116.4
11	D25-E	112	123	11	77	82	5	113.4
12	E2-E	111	121	10	77	82	5	111.4
13	E8-E	113	121	8	77	82	5	115.5
14	E16-E	113	120	8	77	83	6	113.4
15	E18-E	112	121	9	76	82	6	112.5
16	E21-E	113	121	8	77	82	6	114.2
17	E24-E	113	122	9	77	83	6	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/ [27]

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: https://www.medicinenet.com/ (Medically Reviewed on 12/5/2024) [26]

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: WHO/ISH definition and classification of Blood pressure level (2021) [27]

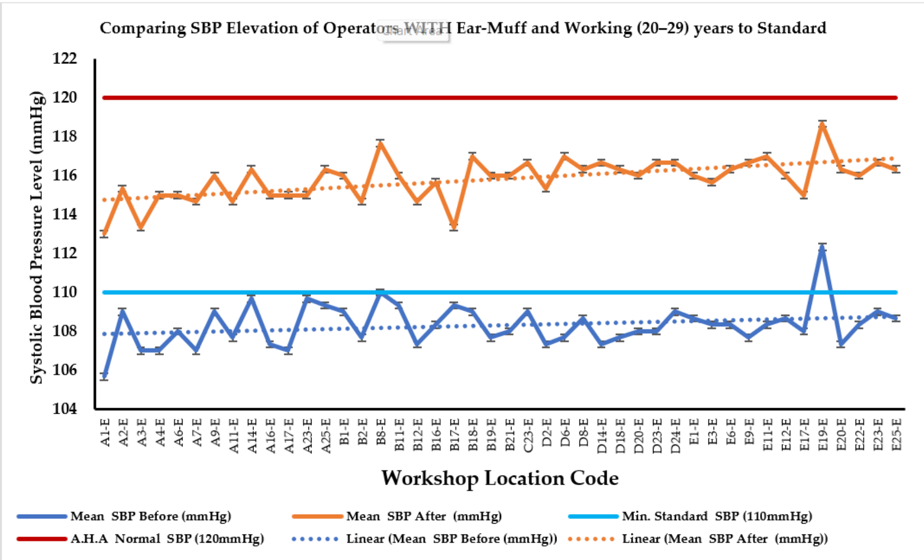

Figure 7. Comparing SBP Elevation of Operators WITH Ear-Muff and Working (20–29) years to A.H.A standard

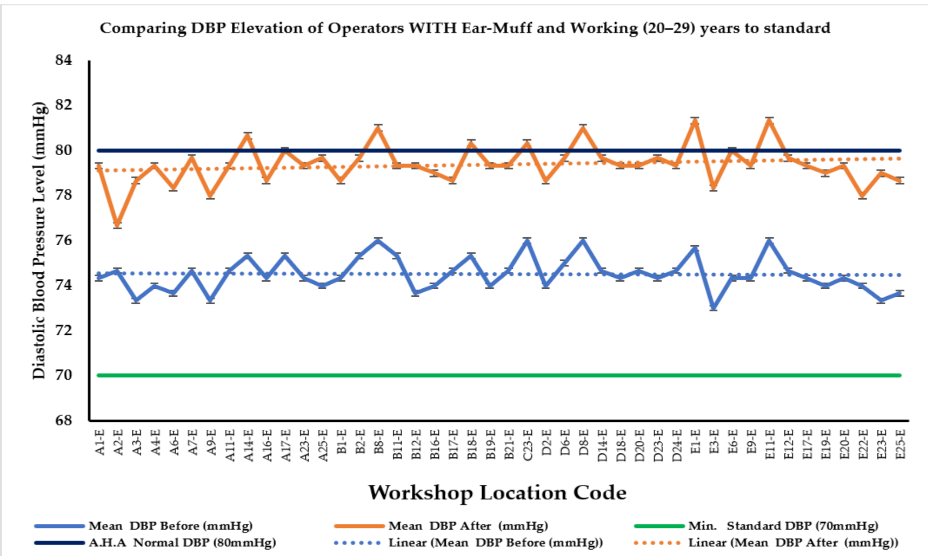

Figure 8. Comparing DBP Elevation of Operators WITH Ear-Muff and Working (20–29) years to A.H.A standard

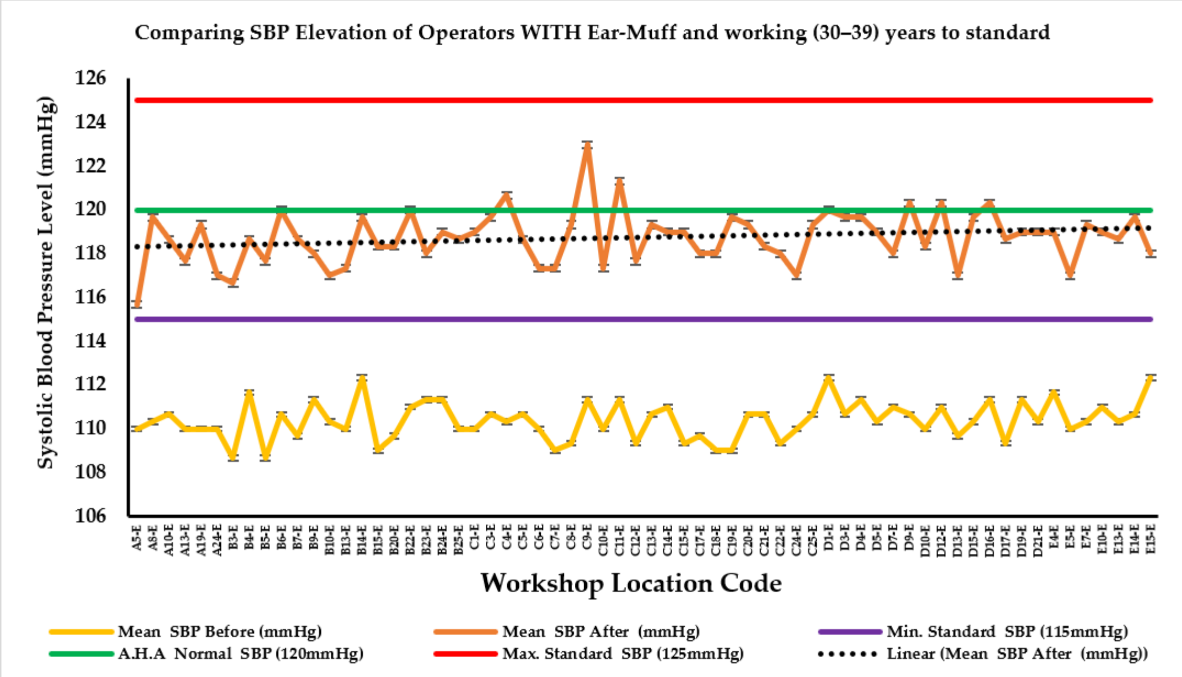

Figure 9. Comparing SBP Elevation of Operators WITH Ear-Muff and working (30–39) years to A.H.A standard

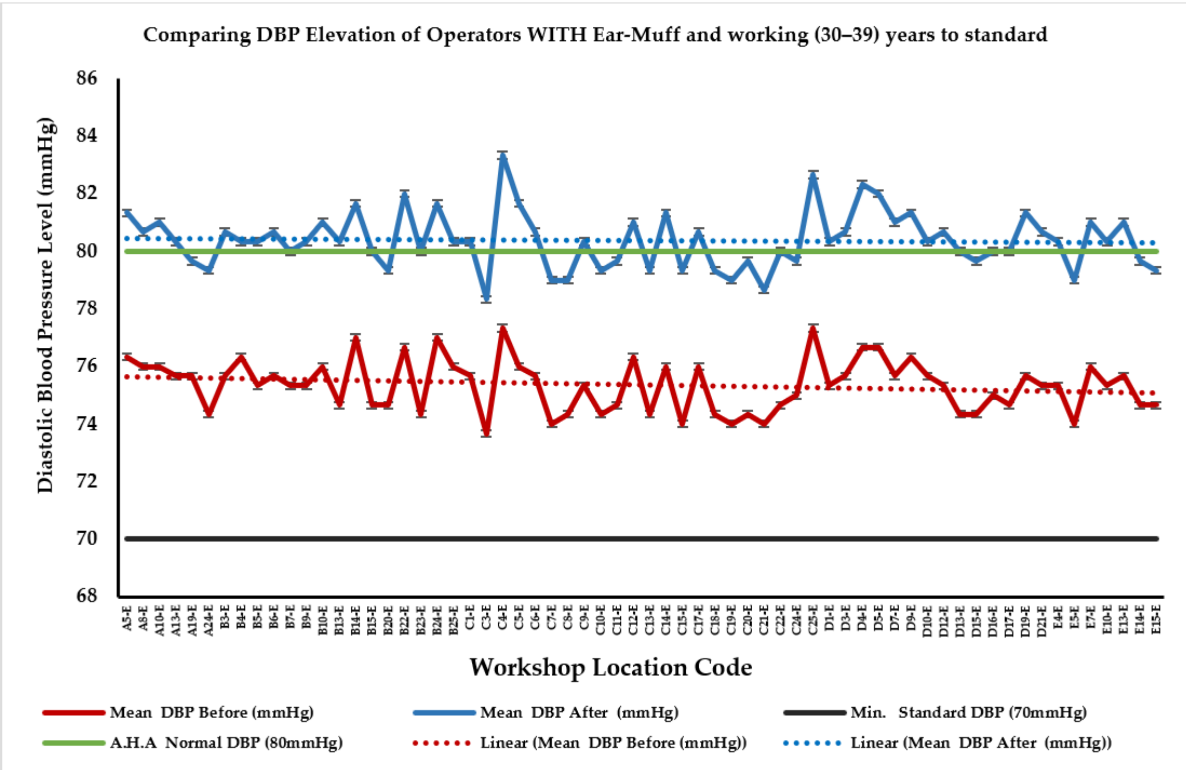

Figure 10. Comparing DBP Elevation of Operators WITH Ear-Muff and working (30–39) years to A.H.A standard

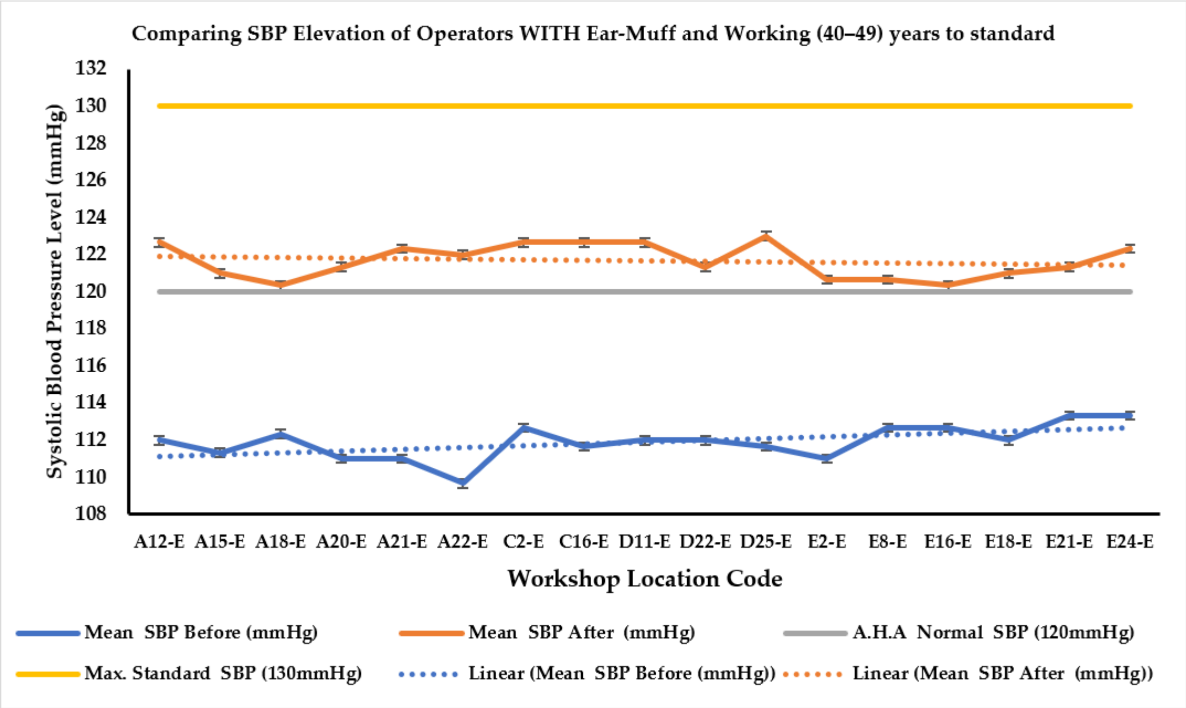

Figure 11. Comparing SBP Elevation of Operators WITH Ear-Muff and Working (40–49) years to A.H.A standard

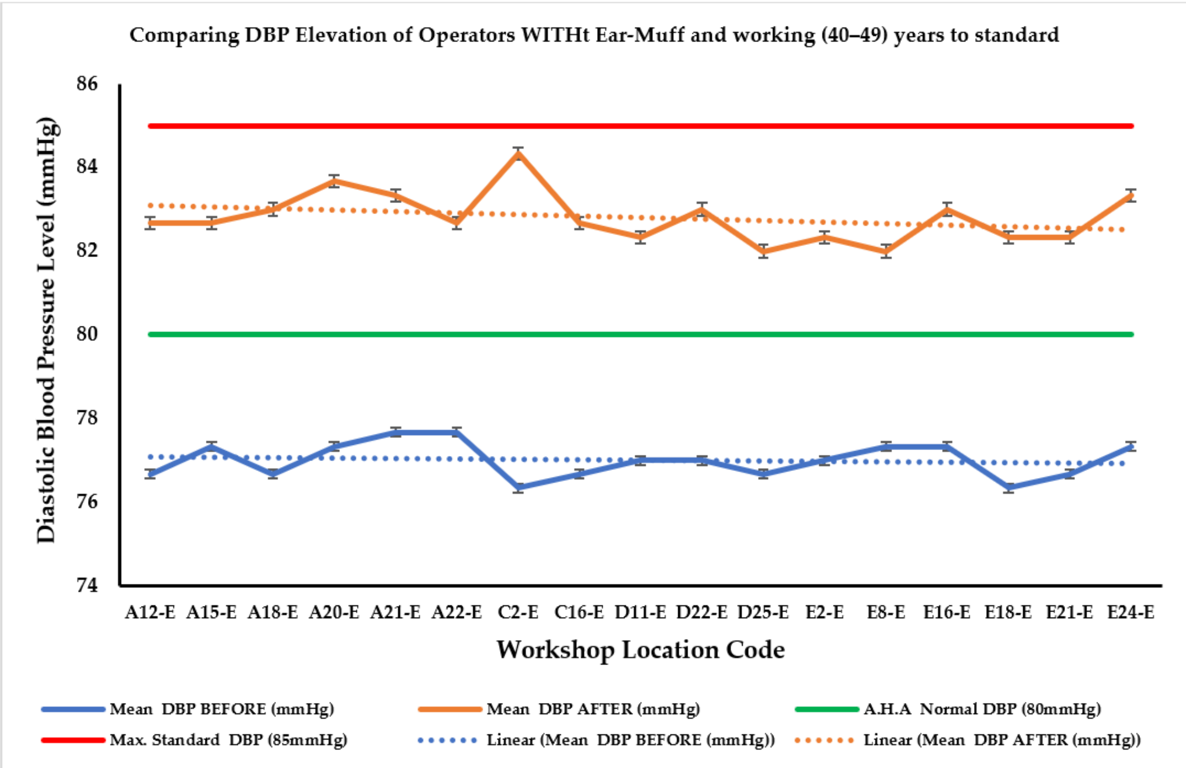

Figure 12. Comparing DBP Elevation of Operators WITHt Ear-Muff and working (40–49) years to A.H.A standard

IV. DISCUSSIONS

All operators wearing ear muffs had SBP elevation after operating the machines are within the recommended limit and below 120 mmHg, with mean SBP values ranging from 113 mmHg to 119 mmHg and a group mean of 116 mmHg, according to Figure 7, which compared SBP changes to the AHA standard for the age group 20 to 29 years. Additionally, it was discovered that the group's SBP elevation ranged from 4 to 9 mmHg. Figure 8 illustrates how the DBP of the same age was also compared to the standard. DBP varied from 77 to 81 mmHg, with an elevation of 2 mmHg to 7 mmHg and a mean of 79 mmHg, which is within the age group's recommended limit. Furthermore, from figure 7 and figure 8, the mean elevation of SBP/DBP for the operator with ear muff was found to be 8/5 mmHg while operating angle grinder or aluminium cut-off and mitre saw machine and exposed to sound pressure levels ranging from 106.8 to 116.4 dBA.

Figure 9, which compared the SBP of age group 30 to 39 years to the AHA standard, showed that 61 operators had SBP less than or equal to the 120-mmHg normal level, while 3 operators had values greater than 120 mmHg, with values ranging from 121 to 123 mmHg, which is still within the recommended limit for the age group. The SBP ranged from 115.7 to 123.0 mmHg with a mean value of 118.8 mmHg, an SBP elevation from 5.6 to 11.7 mmHg. The DBP of the same group was compared to standard as shown in figure 10; it shows that 35 operators had DBP ≤ 80 mmHg, while 26 had DBP > 80 mmHg with a value range of 81 to 83 mmHg, which is still within the recommended limit for the group. The DBP elevation for the group ranged from 4 to 6 mmHg. Additionally, from figure 9 and figure 10, the mean elevation of SBP/DBP was found to be 8/5 mmHg while operating angle grinder or aluminium cut-off and mitre saw machine with ear muff and exposed to a sound pressure level of ranging from 109.9 to 116.4 dBA.

All operators using ear muffs had SBP elevation within the suggested limit and below 120 mmHg, with mean SBP values ranging from 120.3 mmHg to 123.0 mmHg and a group mean of 121.7 mmHg, according to Figure 11, which compared SBP changes to the AHA norm for the age group 40 to 49 years. Additionally, it was discovered that the group's SBP elevation ranged from 8.0 to 12.2 mmHg. 15 operators had SBP > 120 mmHg with values of 120.6 to 123.0 mmHg, which is normal for 40 to 49 years, whereas two operators had SBP values ≤ 120 mmHg. Figure 12 illustrates how the DBP of the same age was also compared to the standard. DBP varied from 79.7 to 83.6 mmHg, with an elevation of 3.1 mmHg to 6.3 mmHg and a mean DBP of 82.5 mmHg, which is within the age group's recommended limit. Furthermore, when using an angle grinder or an aluminium cut-off and mitre saw machine and being subjected to a sound pressure level between 111.4 and 117.6 dBA, the mean elevation of SBP/DBP was determined to be 9.8/5.5 mmHg (figures 11 and 12.

The operators with ear muffs were subjected to a mean sound pressure level of 112.4 dBA for 20 to 29 years, which causes a mean elevation of 8/5 mmHg and a mean fluctuation of SBP/DBP of 116/79. The SPL/SBP had a negligible association with a Pearson correlation of 0.323 and an R^2 value of 0.1040 and 10.40%, whereas SPL/DBP had a weak correlation with a Pearson correlation of 0.1906 and an R^2 value of 0.0363 and 3.63% after using the machine. The operators are exposed to a mean sound pressure level of 112.7 dBA for 30 to 39 years, which causes a mean elevation of 8/5 mmHg and a mean variation of SBP/DBP of 119/80. The SPL/SBP had a negligible association with a Pearson correlation of 0.119 and an R^2 value of 0.0142 and 1.42%, whereas SPL/DBP had a negligible correlation with a Pearson correlation of 0.006 and an R^2 value of 0.00036 and 0.036% after operating the machines. The operators are exposed to a mean sound pressure level of 113.9 dBA, when using the machine for 40 to 49 years, which causes a mean elevation of 10/6 mmHg and a mean variation of SBP/DBP of 122/83. The SPL/SBP had a negligible Pearson correlation of 0.271 and an R^2 value of 0.0734 and 7.34%, whereas SPL/DBP had a negligible correlation with a Pearson correlation of 0.129 and a R^2 value of 0.0166 and 1.66%.

V. CONCLUSION

In conclusion, the research results showed a very insignificant link between the operators' SBP/DBP variation and the sound pressure level they have been exposed to when wearing an earmuff and using an industrial machine such as an angle grinder or an aluminium cutter at the workshop. Furthermore, there is no connection between noise exposure at the workshop and changes in SBP/DBP for an operator wearing an earmuff because the SPL has little to no effect on the operators' blood pressure. This has further demonstrated how important an earmuff is for reducing the intensity of noise that enters the ears when working in a workshop or other noisy environment. However, improper placement of earmuffs can cause thermal discomfort and interfere with protective glasses, which lowers the earmuffs' effectiveness.

VI. RECOMMENDATION

Therefore, in order to protect their health, machine operators must wear earplugs and other personal protective equipment (PPE) and monitor their blood pressure on a regular basis. To help to mitigate the consequences of exposure to noise pollution, regulatory bodies should also mandate the use of ear protection, such as earmuffs, earplugs, etc., at workshops. Because of the high level of risk associated with their profession, operators are encouraged to routinely check their blood pressure and hearing sensitivity. Earmuffs are especially important in preventing irreversible hearing loss since they block loud equipment noises that exceed 85 dB. They also enhance people's capacity to concentrate and focus at work by lowering the stress, exhaustion, and annoyance caused by loud noise.

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