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Effect of Noise Pollution Exposure on Some Physiological and Immunological Parameters in Rabbit's Blood

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ABSTRACT

The study comparatively evaluates the effect of Broadband white noise at 90dB intensity on hematological, sex hormones, immunoglobulins, lipid profile and biochemical parameters for five or 12 days using eighteen adult male and female rabbits. Noise exposure to rabbits caused a highly increase in its hematological parameters such as RBC, WBC, Hb, PLT, biochemical parameters such as (Glucose. Urea, Uric acid, Creatinine), lipid profile such as (Triglycerides and Cholesterol). Immunoglobulins such as (IgG and IgM) and Cortisol hormones, while sex hormones such as Estrogen and Testosterone level decreased significantly. The results indicated that the noise exposure could be harmful changes and can cause adverse effects to the body immune defense system.

Keywords- Rabbits, white noise, biochemical parameters.

I. INTRODUCTION

Noise, defined as disturbing and unwanted sound is perceived as an environmental stressor and nuisance. Exposure to noise causes many health problems such as hearing loss, sleep disturbance, and impairs performance, as well as effecting cognitive performance, it also increase aggression as well as leading to coronary heart disease, hypertension, higher blood pressure, increased mortality risk, serious psychological effects, headache, anxiety and nausea (Khitam et al.,2015).

Noise is an erratic combination of sounds of different strength and frequency, able to have an adverse effect on the body, noise can be defined as any unwanted sound that irritates or distracts people, which can cause an adverse psychological or physiological effect on humans (Mohd et al., 2022). Noise implies harmful effects toward people and the environment if left uncontrolled, noise pollution can lead to safety and health problems; it can cause hearing loss and increase heart rates, continues noise of 85-90 decibels (db), Lead to loss of hearing in industrial environments (attarchi et al., 2020). In workers exposed to noise, blood pressure and heart rate often increase as the body's response to physical stress (permana et al., 2024).

Mental health primarily depends on the quality of life, which can be affected by various environmental factors, such as noise (Andrzej and Jolanta, 2021)

The human ear is known to be sensitive to a wide range of intensities, ranging from 0 to 180 decibels, according to who, more than 70 decibels of sound will be harmful to health (Tej bahadur etal., 2024).

Cells of the immune system are present in the adult cochlea and respond to damage caused noise exposure (Vikrant Rai et al., 2020).

Noise is one of the world's most widely distributed cause of environmental stress prenatal exposure to noise is reported to have detrimental impact on the development of the fetus as well as neonates (Barzegar et al., 2015)

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Noise, the unwanted and damaging sound levels, has dramatically increased due to the recent increase of global technological developments including cars, factories, aircraft, and others that cause noise stress which is one of the leading global causes of environmental stress (salehpour et al.,2018). Noise stress is a body condition that affects the balance between the body and its surrounding stress is long or short-term. Short term stress can last for a couple of hours, but long term persists a few months, long term stress causes numerous health problems, such as insomnia, poor diet, respiratory infections (khanam et al.,2017).

Studies have shown that noise exposure affects the level of brain neurotransmitters, cause dendrites atrophy and increases corticosterone plasma levels (Tao et al.,2015). The most common isotype in the body is IgG, so it is the major Ig in serum and it is major Ig found in extravascular spaces, it has the longest serum half-life, additionally IgG antibodies directly support an immune response by neutralizing pathogens and viruses, which are then engulfed by phagocytosis and eliminated (Janeway et al.,2001).

The aims of this study to demonstrate the effect of exposure to noise stress with different durations on the physiological and immunological states of adult men and women.

II. MATERIALS AND METHODS

In the present study, eighteen adult male and female rabbits, these rabbit aged one years old were used in the initials present study 2700± 200 gram body weight, nine male and nine females. Animals are socially housed in standard cages (3 in each cage, male or female). Rabbit were randomly assigned to noise stress exposure after two weeks of the acclimatization. The experiment are achieved between 1st December 2024 to 1st February 2025. The rabbits in this study divided randomly into three groups, each group of six rabbits (3 adult male) and (3 adult females). The first group were left without exposure to stress which was used as a control (G1), the second group the rabbit were exposed to 90 dB continuous noise intensity for 4 hours daily for 5 days (G2) and the third group exposed to90 dB continuous noise intensity for 4 hours daily for 12 days (G3).

After 2 weeks adaptation, twelve rabbit were randomly assigned and prepared for noise stress exposure, in control 6 rabbit (3 males and 3 females) were left without being stressed (G1). Broadband white noise (20-2000) HZ at (90 dB) intensity (Salehpour et al.,2018) was applied by application of an android application (frequency sound generator) and (sound level meter) to measure sound intensity). Then the phone was connected by Bluetooth to the multimedia speaker (BK 868) which was fixed at 30 cm over the animal cages. During the exposure period to noise stress, these animals are kept in the stress room to prevent other unnecessary stress on the animals.

After the end of experiment the 5ml blood samples were collected from the each doe were collected from direct cardiac puncture by a 22 gunge sterile needle, 1.5ml of the samples was put into tube containing K3-EDTA the rest of the sample was collected in sterile tube without anticoagulant. All blood samples were transported to the laboratory at 4°C within 2 hours, serum was separated from the blood by centrifuged 3000 rpm for a period 15 minute, which transferred to and frozen at -20°C until biological analysis. hematological analysis on K3- EDTA samples were completed on day collection, blood samples with K3-EDTA anticoagulant were used for the determination of hematological parameters, i.e white blood cells (WBC), red blood cells (RBC), blood hemoglobin (Hb) and platelets (PLT) after the serum used for a IgG, IgM, Cortisol, Estrogen, Testosterone, Glucose, Triglycerides Cholesterol, Urea, Uric acid, and Creatinine.

Results were given as mean± SD, data are analyzed by one –way analysis of variance (ANOVA) which is followed by Fisher's test, when $p \leq 0.01$ differences were deemed significant.

III. RESULTS AND DISCUSSION

Table 1 shows the comparison of the (mean ± SD) RBC ($\times 10^6$ /mm^3), WBC ($\times 10^6$ /mm^3), HB (g/ dI) and platelet ($\times 10^3$/mm^3) among control group (G1) and different studies groups which were under noise stress in the male Rabbits and in the female table 2. There was a highly significant ($p \leq 0.01$) increased in RBC count in G2 group (6.5± 0.22) and (7.2± 0.21) in G3 compared with control group (5.2±0.31).

Comparable results are obtained at the level of WBC at the same time points, WBC increased significantly ($p<0.01$) in G2 (8.63 ±0.28) and (8.84 ± 0.31) in G3 compared with control group (6.14 ± 0.42). On the other hand, Hb increased significantly ($p<0.01$) in G2 (13.4 ±1.31) and (15.2 ± 1.44) in G3 compared with G1group (10.6± 1.12). Essentially the same differences are observed in the number of platelets at the same time points. Platelet number increased significantly ($p \leq 0.01$) in G2 (405 ± 32.3) and (510± 41.3) in G3 compared with control group G1 was (303± 41.2).

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Table (1) Effect of noise stress on Red Blood Cell (RBC), White blood cell (WBC), Blood Hemoglobin(Hb) and platelets (PLT)in the male Rabbits.

Groups	RBC $\times 10^6$ /mm^3 (mean ± SD)	WBC$\times 10^6$ /mm^3 (mean ± SD)	Hb g/ dI (mean ± SD)	PLT$\times 10^3$/mm^3 (mean ± SD)
Control G1	5.2±0.31 a	6.14±0.42 a	10.6±1.12 a	303±41.2 a
G2	6.5± 0.22 b	8.63±0.28 b	13.4±1.31 b	405±32.3 b
G3	7.2±0.21 b	8.84±0.13 b	15.2±1.44 c	510± 41.3 c
LSD	1.2	2.2	1.6	101

*Different letters represent a significant difference between means in columns (p≤0.01).

In the Table 2 there were no differences in all RBC, WBC, Hb and PLT indices between male and female noise stress groups.

Hematological studies show the physiological response of an animal to its internal environment hematological parameters like RBC, Hb, WBC and PLT have been identified as a good indicator of the immune status of the animal. The results of this study are in accordance with past studies. Nwuke et al., (2023) showed that the hematological parameters of the blood sample from the Wister rats which include there RBC, WBC, PLT, Hb exposed to high noise level (85 db- 105 db) increased significantly when compared to the control. This results also agrees with the work done by sabahi et al.,(2002) which they discovered that the number of RBC.WBC. Hb and hematocrit of blood cells of mice increase due to noise exposure, which is caused due to effects of vibrating sound on the immune system.

Table (2) Effect of the noise stress on Red Blood Cell (RBC), White blood cell (WBC), Blood Hemoglobin (Hb) and platelets (PLT)in the female Rabbits.

Groups	RBC $\times 10^6$ /mm^3 (mean ± SD)	WBC$\times 10^6$ /mm^3 (mean ± SD)	Hb g/ dI (mean ± SD)	PLT$\times 10^3$/mm^3 (mean ± SD)
Control G1	5.2±0.41 a	5.4±0.22 a	10.2±0.75 a	285±65.4 a
G2	6.1± 0.65 b	7,8±0.44 b	11.8±0.31 b	465±81.5 b
G3	6.3±0.61 b	8.1±0.81b	13.8±0.45 c	485± 51.5 b
LSD	0.8	2.3	1.5	150

*Different letters represent a significant difference between means in columns (p≤0.01).

And hence increasing blood parameters. Also, Litman etal., (2005) in his work explained that noise pollution can increase hemoglobin, RBC count in oil refinery workers, while the mechanism of this process remained unclear. Similar results were also observed by Mohammadi et al., (2016) who reported that mean difference RBC number, WBC number and level of hemoglobin were increased among workers in the production section over five consecutive on years, that is mean exposure to noise may have a significant effect on individual's blood parameters, which will cause harmful effects on worker health. Exposure the rabbit to noise caused increase WBC and hemoglobin this induction of WBC is a positive response for survival due to cell mediated immune response of animals leukocytosis was manifested by lymphocytosis which were the main features of differential leukocytic count (Khitam et al.,2019).

The level of blood glucose (ng/ml) was increased highly significantly (p<0.01) in control group (94.20± 1.9) in comparison with G2 (81.32± 3.2) and (72.31±5.1) in G3Table3.

The decreasing in the level of glucose was in agreement with (khitam et al.,2015) who found that the serum glucose, triglycerides and total cholesterol mean values of rabbits blood affected by noise exposure decreased serum glucose level by 36.73% compared the control level after 50 days noise exposure, on the other hand triglycerides increased gradually, also, mean values of serum cholesterol was significantly increased by 13.5% compared with control.

The increment in cholesterol and Triglycerides explained on indirect action of noise on lipid metabolism or lipid peroxidation (Abdel Aziz et al., 2010).

Table 3 Glucose, Triglycerides and Cholesterol in male Rabbits after noise exposure.

Parameter	Control (G1) (mean±SD)	G2 (mean±SD)	G3 (mean±SD)	LSD
Glucose (ng/ml)	94.20±1.9 a	81.32±3.2 b	72.31±5.1 c	8.5

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Triglycerides (mg/dI)	99.2±3.6 a	115.16±9.8 b	117.31±8.2 b	10.5
Cholesterol (mg/dI)	172.98±11.2 a	181.33±15.2 b	175.35±9.8 b	8.5

*Different letters represent a significant difference between means in columns ($p \leq 0.01$)

Data revealed highly significant decrease in serum glucose levels in rabbits in response to noise exposure. Noise exposure may indirectly play a specific role in carbohydrate metabolism probably due to enhancing gluconeogenesis and glucose mobilization to blood (Abdel Aziz et al.,2010). The change observed in serum Triglycerides and Cholesterol content in response to treatment by noise, take place in the liver due to imbalance between the normal rabbits of lipid synthesis, utilization and secretion (Khitam et al.,2015).

A study conducted by (Sumardiyono et al.,2017) found an association between noise exposure, blood glucose level with lactate levels in textile industry workers, high noise exposure can ultimately lead to increased lactate, Ismail et al., (2017) found in rabbit blood that the noise exposure decreased the concentration of serum glucose, total protein, globulin and albumin.

Urea (mg/dI) showed significantly ($p<0.05$) increase in G2 and G3 groups respectively (29.8±1.4 and 30.2±1.5) in comparison with control group (27.1±1.2). Also, uric acid(mg/di) increased significantly ($p<0.05$) in G2(3.87±0.1) and G3 (3.94±0.1) in comparison with control group (3.09±0.2). On the other hand, means values of creatinine was significantly ($p<0.05$) increased in G2(0.86±0.02) and G3(0.93±0.01) compared with control group (0.81±0.03) Table 4.

The significant in blood urea is the principal and product of protein catabolism an accelerated amino acid deamination for gluconeogenesis is probably an acceptable postulate to interpret the elevated level of urea.

Table 4 Urea, Uric acid and Creatinine in male rabbit's after noise exposure.

Groups	**Urea(mg/dI) (mean±SD)**	**Uric acid (mg/dI) (mean±SD)**	**Creatinine(mg/dI) (mean±SD)**
Control G1	27.1±1.2 a	3.09±0.2 a	0.81±0.03 a
G2	29.8±1.4 b	3.87±0.1 b	0.86±0.02 b
G3	30.2±1.5 b	3.94±0.1 b	0.93±0.01 c
LSD	2.2	0.6	0.4

*Different letters represent a significant difference between means in columns ($p \leq 0.05$)

The elevation of blood urea is a good indicator for kidney disorders.

Additionally, the presence of some toxic compounds might increase blood urea. Uric acid is the end product of the catabolism of the tissue nucleic acid,i.e. purine bases metabolism (Bishop et al.,2005). The highly significant increase in uric acid concentration may be due to degeneration of purines or to increase uric acid levels by either overproduction or inability of excretion.

Creatinine is the last variable of non protein constituents, it appears in serum in amounts proportional to body's muscles mass and is more readily exerted by the kidney's than urea and uric acid. Elevated creatinine concentration is associated with abnormal renal function, especially as it relates to glomerular function (Khitam et al.,2019).

The highly significant in blood urea is the principal end product of protein catabolism an accelerated amino acid deamination for gluconeogenesis is probably an acceptable postulate to interpret the elevated level of urea. The increment in blood urea, might be also due to the destruction of RBCs during the treatment. The presence of some toxic compounds might increase blood urea and decrease plasma protein (Khitam et al.,2015). Moreover, the serum uric acid levels exhibited an increase in the treated rabbit by inability of its excretion by urinary system (Khitam et al.,2015).

Table 5 show the comparison of the mean IgG(mg/dI) and IgM(mg/dI) which are under noise stress G2 and G3 by comparing the control group G1 and by comparing the male with female groups.

IgG levels highly significantly ($p<0.01$) increase in stress groups G2 and G3 respectively (170.2±11.2 and 212.2±9.2) in compared with control group (98.9±9.7) in male rabbit. Also there was significantly ($p<0.01$) increase in female rabbit G2 and G3 groups (159.2±10.4 and 190.2±8.7) respectively compared with control group (101.3±8.3).

IgM is one of the most important classes of Ig in the body. IgM (mg/dI) showed highly significant ($p<0.01$) increase in G2 and G3 groups respectively (100.3±2.3 and 112.3±3.4) in comparison with G1group (90.1±4.2) in male rabbit.

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Interestingly, IgM levels increased significantly ($p<0.01$) in female rabbit. G2 and G3 were (96.5±3.5 and 98.8±2.3) respectively compared with control group (84.2±4.5).

Table 5 Effect of the noise on immunoglobulin in male and female Rabbits.

Groups	IgG (mg/dl) (mean±SD)		IgM (mg/dl) (mean±SD)	
	Male	female	Male	Female
Control G1	98. 9±9.7 a	101.3±8.3 a	90.1±4.2 a	84.2±4.5 a
G2	170.2±11.2 a	159.2±10.4 b	100.3±2.3 b	96.5±3.5 b
G3	212.2±9.2 c	190.2±8.7 b	112.3±3.4 c	98.8±2.3 b
LSD	50	55	10	11

*Different letters represent a significant difference between means in columns ($p <0.01$)

There were no significantly differences in IgG and IgM levels between male and female, the levels of IgG and IgM were significantly higher in male compared to female.

The results shown significant increased in IgG and IgM may be explained as the release of glucocorticoid hormones cause a decrease in blood leukocyte numbers which may be due to redistribution rather than the destruction of leukocytes from the blood to other organs of the body in preparation for immune challenges. Redistribution in prominent for T and B lymphocyte and monocyte(Dhabhar,2002; Zainab et al.,2024). And this may be the cause of increased serum level of IgG and IgM inspite of decreases in blood lymphocytes count. IgG is the predominant isotype found in the body, so it is the major Ig in serum (systemic immunity) and it is the major Ig found in extravascular spaces. It has the longest serum half-life of all Igs. IgG antibodies also contribute directly to an immune response including the neutralization of toxins and viruses which then destroyed by phagocytosis (Janeway et al.,2001).

Table 6 shows the effect of noise on the sex hormones, Testosterones (ng/ml) in male and estrogen (pg/ml) in female. Testosterone and estrogen levels were significantly ($p<0.01$) decline in stress groups.

Estrogen level was decreased gradually in G2(7.67±0.12) and G3 (6.32±0.85) compared to the control group (9.81±0.45). Testosterone levels decreased in stress group G2 (1.652±0.016) and G3 (1.251±0.013) comparing with control group (1.916±0.012).

These results are similar of these of Chamkors et al.,(2016) reported that the noise pollution effects on morphometric parameters of testicular tissue, cortisol and testosterone, it increases cortisol and decreases testosterone level, who showed in male rats were exposed to (90,105 dB) noise. However, Chamkors et al., (2016) also reported that the problem of sterility and infertility resulting from noise pollution (119 dB) reduced the concentration of the testosterone and increased cortisol. So low levels of testosterone have harmful effect on ejaculate quality and fertility and with lower sperm volumes the reduced testosterone level stop and disrupt spermatozoa maturation and results in germ cell atrophy (Swami et al.,2007).

Table 6 Effect of the noise stress on the stress hormones (Cortisol) and sex hormones (Estrogen and Testosterone) in the male and female Rabbit.

Groups	Cortisol nmol/L (mean±SD)		Estrogen pg/ml (mean±SD)	Testosterone ng/ml (mean±SD)
	Male	Female		
Control G1	3.38±0.6 a	5.58±o.41 a	9.81±0.45 a	1.916±0.012 a
G2	5.83±0.21 b	13.11± 0.31 b	7.67±0.12 b	1.652±0.016 b
G3	9.42± 0.67 c	20.83±2.2 c	6.32±0.85 c	1.251±0.013 c
LSD	2.1	7.5	1.21	0.198

*Different letters represent a significant difference between means in columns ($p <0.01$)

Table 6 shows the comparison of the mean±SD cortisol (nmol/L) in male and female. Data in these clearly shown highly significance ($p<0.01$) increased in cortisol level in G2 (5.83±0.21) and G3 (9.42± 0.67) compared with control group (3.38±0.6) in male and in female also,G2 (13.11± 0.31) and G3(20.83±2.2) highly significant ($p<0.01$) increased compared with G1(5.58±o.41). Norepinephrine convert into epinephrine by the cortisol dependent enzyme. So any form of stress that increases the cortisol level stimulates epinephrine production (Bishop et al., 2013). Corticosteroid hormone are very

lipophilic and therefore easily pass the blood- brain barrier, in principles reaching all cells and stimulate neurotransmitter production (Krugers et al.,2012). Noise exposure can increase blood glucose levels, which can ultimately lead to increased lactate levels.

This is because noise exposure can cause stress, which can increase cortisol production, cortisol can increase glucose level (Sumardiyono et al., 2017). The higher cortisol levels during stress resulting from the secretion of ACTH which stimulated by neurotransmitters, increased levels is the cause of decline the testosterone levels due to the activity of glucocorticoid receptors in leydig cells due to decreased response to these cells to LH.

In current study, the estrogen in female rabbit decline with exposure to stress, these findings were similar to other study, that showed decrease in level of estrogen in mice exposed noise compared to control group (Shafiei et al.,2017; Zainab,2020).

Endocrine system of mammals regulate the body functions to protect the homeostasis in cases of basal and stress situations. The hormones secreting from endocrine system are the important variables that regulate the metabolic activity. Therefore, it was investigate exposure of 900MHz radio frequency radiation can increased testosterone, estradiol, cortisol hormones after 3 months exposure in rabbits (Beyza et al.,2009).

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