Chapter 83

The effect of noise pollution on animal welfare - a case study in balb/c mice

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ABSTRACT
The quality of life is determined primarily by the quality of the environment. Many variables act on the environment, including noise pollution, present in everyday life. According to the World Health Organization, above 55 db, the body begins to suffer the impact of noise, causing mild stress and excitement. One of the main responses is activation of the hypothalamic-pituitary-adrenal axis, causing the release of glucocorticoids. These hormones act on the energy metabolism, increasing the amount of free fatty acids in the bloodstream. Thus, changes in lipid metabolism have been reported after stressful situations. In this experiment we used *Mus musculus* balb/c mice submitted to chronic sound stress, at 90dB, for 30 days, at night, from 8 pm to 2 am the next day. The animals were euthanized by decapitation after anesthesia, and the blood collected was used to measure cholesterol, triglycerides, and glucose. During the experiment the animals' weight was monitored, and there was no considerable variation between the control and experimental groups. Regarding the biochemical parameters, there were statistically significant differences in the levels of cholesterol, triglycerides, and glucose. The significance levels, or p values, were 0.067 (p less than 6.7%); 0.053 (p less than 5.3%), and 0.000 (p less than 0.0009%), respectively. With the present study, it can be concluded that stress hormones interfere with cholesterol, triglyceride and glucose metabolism. The chronic noise stress model can be considered a good environmental stress model that mimics urban stress.

Keywords: Noise stress, Glucocorticoids, Biochemical parameters, Pollution, Environmental parameters.

1 INTRODUCTION

About stress and the pathologies related to it, despite the existence of a comprehensive and numerous literature on the subject, there is no clear definition on the subject scientifically accepted by all (STRATAKIS; CHROUSOS,1995; PIMENTEL; ALVARES, 1992; PAULI; LEME; CREPILHO et al., 2005).

The concept and expression stress, "set of reactions of the organism to physical, psychic, infectious and other aggressions, capable of disturbing its homeostasis..." according to Aurélio, were introduced in the medical literature and popularized by Selye (1976), who, besides not dismissing the possibility of the existence of response patterns of the organism to specific stressing stimuli, still emphasized that such responses did not constitute stress by themselves.

Through this concept, several authors have written about the differences and similarities that can be observed between a variety of responses, facing the diverse nature of stressful stimuli, such as:

immobilization (STRATAKIS; CHROUSOS,1995), hemorrhage, thermal, pain, hypoglycemia, sound wave (PIMENTEL; ALVARES, 1992) and exercise (PAULI; LEME; CREPILHO et al., 2005).

The definition of stress can be given as: a state of readiness and alertness of the organism, facing environmental threats that trigger mechanisms of specific compensatory responses, aiming at the maintenance of homeostasis. Reflections of the activation of central neural and glandular circuits are, therefore, adaptive physiological responses that generate a set of reactions to aggressions of physical, infectious, psychic and other kinds, capable of disturbing the balance of the internal environment.

Expanding the concept, stress corresponds to a relationship between the individual and the environment in which he/she is, between aggression and the organism's response to any stimulus that excites, irritates, frightens or makes him/her happy. In this context, stress is part of the daily life of most living beings.

Nowadays it is known that stress is associated with the development of several diseases, and with this, experimental researches are multiplying, with the purpose of proposing ways to control the negative aspects of stress, which certainly demonstrate a strong correlation between the mental and physical state of the individual.

The responses of the organism to stress situations are part of a biological adaptive system (CHARVAT et al., 1964) and involve several processes. The main component of this response is of neuroendocrine nature mediated by the activation of the hypothalamic-pituitary-adrenal (HHA) axis (CULLINAN et al., 1995; JAFERI et al., 2003; LEONARD et al., 2005; SORRELLS and SAPOLSKY, 2007) causing the release of glucocorticoids. These hormones, cortisol in humans and corticosterone in rodents, act on the energy metabolism, for example, increasing the amount of free fatty acids in the bloodstream, and may influence food intake (MICHELSON et al., 1995; DALLMAN et al., 2004; FLEUR, 2006).

It is possible to correlate alterations suffered by lipid metabolism in stress situations, since many enzymes responsible for biosynthesis and degradation are modulated by hormones released in stress situations, such as adrenaline and glucocorticoids, consequence of the organism's response to stress (RICART-JANÉ et al., 2002). Thus, some studies consider that stress causes high levels of total cholesterol, LDL-cholesterol and a decrease in HDL-cholesterol, suggesting an increase in cardiovascular diseases.

Noise pollution is an example of stress inducing agent, being the set of sounds, noises, noises coming from the same source, or several sources in an environment. This is a serious problem that has been affecting the world population, especially in urban centers (KAM et al., 1994).

The problem of degrading stress in the body begins around 65 dB, with an increase in the level of cortisone in the blood and a drop in immune resistance. Above 70 dB, the organism becomes subject to degenerative stress, shaking mental health, besides interfering with the autonomic nervous system, which

feeds the regulatory mechanisms of blood pressure, blood lipid and glucose levels, viscosity, and coagulation.

The objective of the present study was to verify possible stressful effects caused by noise pollution, and possible effects on the lipid profile of balb/c mice.

2 METHODOLOGY

We used 36 balb/c mice, 18 males and 18 females (60 days old at the beginning of the treatment) from the Nico Nieser vivarium of the Ecology & Evolution Department of the Universidade Federal do Triângulo Mineiro. The animals were kept in housing boxes made of polypropylene, measuring 30 X 20 X 13cm, with a floor covered with sawdust. Two animals per box were kept in the experimental room under controlled conditions of temperature and normal light/dark cycle (light on from 7am to 7pm and wide window), with standardized feed and water ad libitum.

The animals were divided into two groups: Experiment and Control. The animals belonging to the Control group remained in the vivarium during the treatment period, and were only exposed to manipulation for cleaning the boxes and for weighing at the end of 30 days. The animals in the Experiment group were subjected to sound stress, with an approximate value of 90 dBA, measured by Instrutemp decibelimeter® ITDEC 4000. Through a Toshiba radio® RRI267, connected to the power source by a digital timer. The noise stress occurred daily, over a six-hour period, from 8 pm to 2 am the next day. The experiment took place over 30 consecutive days.

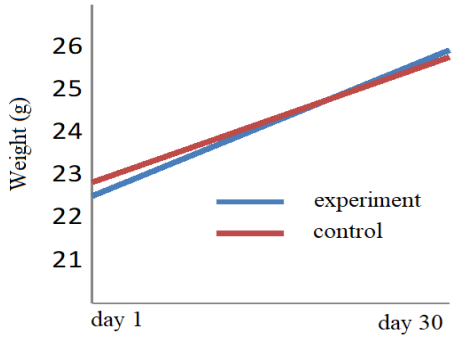
Before drawing blood, the animals were weighed on a Shimadzu digital scale® model UW4200H for comparison between groups. After weighing, Thiopental was applied for anesthesia with a final concentration of 30-40 mg/kg, and the anesthetic state was verified by the absence of reflexes. After confirmation, the animals were submitted to decapitation. The blood obtained from the decapitation was used for cholesterol, triglyceride and glucose analysis using Accutrend Cholesterol, Accutrend Triglyceride and Accutrend Glucose reagent strips, all from Roche® . The reading was performed by Accutrend Plus Roche .®

Statistical analyses were performed using Excel® and Minitab® .

3 RESULTS

In relation to the weight of the animals, considering the average normal body growth of mice, it is observed that the Experiment group presents a negligible weight increase during the 30 days. The same behavior is observed in the control group. This result shows that both groups gained weight over time (Figure 1), although when comparing the weight of animals at the beginning and end of treatment, there is no difference between groups.

Figure 1. Comparison of baseline weight of control and Experiment groups over the course of the 30-day experimental treatment.



For the experiment the sample n was 24, while for the control the sample n was 12 mice. The mean weight of the experimental and control groups at the beginning was 21.583 +1.781 and 22.692 + 2.624, respectively; with minimum and maximum values of 19.0 and 25.7 and 18.9 and 27.0. At the end the weight was 23.796 + 1.801 for the experimental group and 24.617 1.887 and control group; with minimum and maximum values of 21.0 and 27.9 and 21.3 and 27.8 respectively. The weight gain in the experimental and control was 2.213 + 1.571 and 1.900 + 1.419 respectively; with minimum and maximum values of-0.9 and 7.0 and -1.2 and 4.1.

Comparing through analysis of variance the weight gain of the control and experimental groups, the "p" value was 0.566, indicating that the two groups are similar to each other.

The mean cholesterol values of the experimental and control groups at the end of 30 days were 167.92 ± 5.93 and 163.92 ± 6.05, respectively; with minimum and maximum values of 158.0 and 177 and 152.0 and 171.0.

Comparing through analysis of variance the cholesterol values of the control and experimental groups, the "p" value was 0.067 (6.7%), indicating that the two groups are not similar to each other. The probability that the two groups are equal is 6.7%; therefore, considering the low sample "n" the authors consider that this event did not happen at random.

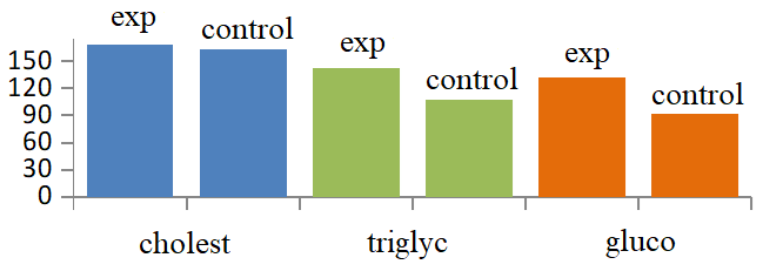
The mean triglyceride values of the experimental and control groups at the end of 30 days were 142.0 ± 56.7 and 108.0 ± 19.50, respectively; with minimum and maximum values of 72.0 and 283.0, and 77.0 and 129.0.

Comparing through analysis of variance the triglyceride values of the control and experimental groups, the "p" value was 0.053 (5.3%), indicating that there was a significant increase between the two groups.

The mean glucose values of the experimental and control groups at the end of 30 days were 132.59 ± 33.33 and 91.67 ± 17.38, respectively; with minimum and maximum values of 84.0 and 215.0, and 59.0 and 120.0.

Comparing through analysis of variance the glucose values of the control and experimental group, the "p" value was 0.000 (0%), indicating that there was an increase in the glucose rate between the two groups.

Figure 2 - Effect of chronic noise stress on cholesterol, triglyceride, and glucose levels at the end of the 30-day treatment. Data expressed as mean (n =24 Experiments; 12 controls).



4 DISCUSSION

Cholesterol, triglycerides and glucose are important biochemical parameters in determining the effects of stress on the body (RICART-JANÉ et al., 2002). In this work these parameters were evaluated in the sound stress model. The results obtained showed differences between the Experiment and Control groups.

Glucocorticoids act on lipids by promoting an increase of free fatty acids in the plasma, in order to stimulate the use of these as an energy source and conserve the body's glucose levels. Likewise, they stimulate gluconeogenesis and glycogenolysis (GUYTON et al., 2002; RICART-JANÉ et al., 2002). In addition, Andrews and Walker published in 1999, a paper on the influence of glucocorticoids on insulin resistance, indicating that they can alter insulin metabolism. In our experiment, the increase in glucose was probably caused by the glucocorticoids released during the chronic stress process.

Concomitantly, literature data demonstrate that animals exposed to immobilization stress for 16 days presented an increase in cholesterol levels, as observed in our experiment. These results suggest an involvement of the stress hormones on these parameters, as well as an interference of the time of exposure to stress on these effects, which may mean the beginning of an adaptation process of the organism facing the stressor agent (RICART-JANÉ et al., 2002).

Analysis of 29 workers subjected to chronic stress indicated increased LDL-Cholesterol (RONSEIN, 2003). In rats it was observed implications of noise stress on the hypothalamic-pituitary-adrenal axis, being observed correlation between sound intensity and adrenal ascorbic acid (AAA) depletion (CRUZ et al, 2009).

Literature data demonstrate that stress can influence energy metabolism indicating that chronic stress can eventually decrease weight and food intake in rodents (MARIN et al., 2007; RICART-JANÉ et al., 2002). Stress can interfere with feeding behavior by the action of hormones of the HHA axis, acting on

hypothalamic nuclei that regulate feeding (DALLMAN et al., 2004; KURIYAMA et al., 2004; MICHELSON et al., 1995).

Studies have shown that the effects of glucocorticoids on food intake depend on the amount of these hormones, and consequently, on the intensity and duration of stress (GAMARO et al., 1999; GAMARO et al., 2003; TORRES et al., 2002). Vasques-Araújo and Prianti (2008) demonstrated that light and sound stress interferes with the behavior of mice, reducing feed intake.

The effects of stress on cholesterol, triglycerides and glucose are not yet fully elucidated since the studies use different stress models, with several duration times, making it difficult to interpret the mechanisms involved. The evaluation of these parameters is important since the increase in lipoproteins and glucose may contribute to the development of cardiovascular diseases (RICART-JANÉ et al., 2002).

Some factors may interfere in the interpretation of such results, such as gender, age and the stress model used (RICART-JANÉ et al., 2002). However, when we analyze the biochemical parameters between the groups, the Experiment group presents higher levels of triglycerides and glucose, and a not very significant increase in cholesterol compared to the control group.

Some authors ponder that several models could be used, including other rodents, such as the species *Meriones unguiculatus,* commonly called gerbil, gerbil or Mongolian squirrel. Gerbils are rodents with hearing very similar to humans, perhaps the best animal model for studies of this nature (SALDEITIS et al., 2014). Sirois (2007) cites that gerbils subjected to extreme noise pollution can present a convulsive picture, but does not cite what this level of sound pressure would be. Andrade et al. (2006) observed that noise pollution can behave as a stressor, but these two authors do not present reference values or discuss the subject. Peterson (1980) points out that usually the reference values used are those adopted for humans and that there are few studies in the area.

5 CONCLUSIONS

In conclusion, noise pollution, used as a stress model, resulted in serum increases in cholesterol, triglyceride, and glucose levels, causing a considerable increase in triglyceride levels and a large increase in the glucose rate. However, cholesterol levels were only slightly increased.

The stress model used was not sufficient to significantly alter the weight of the animals; and it is thought that the chronic noise stress model can be considered a good environmental stress model that mimics urban stress.

The authors ponder that it would be prudent to use *Meriones unguiculatus*, rodents with hearing very similar to that of humans, to carry out further tests, in order to confirm, or not, the findings of the present study.

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