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Effect of Chronic Administration of Lead (Pb) on Aggressive Behaviour among Male Albino Wistar Rats

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Abstract

Research has shown that even low levels of lead (Pb) exposure are dangerous. A variety of toxic effects caused by lead (Pb) exposure have been reported in both human and animal studies, hence, this research study investigated the effects of chronic administration of lead (Pb) on aggressive behaviour among male albino wistar rats.

12 Adult male rats (with weight range betweens 172 kg and 209 kg, X weight 191 kg) were used. They were housed in individual improvised cages and were given food and water ad libitum. The animal room temperature was maintained at normal light/dark cycle. After the period of acclimatization, adult rats were randomly assigned into two groups of six rats each; Rats exposed to lead (Pb) and control. The exposed rats received 10mg per kilogram bodyweight of lead (Pb) solution throughout the duration of the experiment. Observational method of recording was adopted, and independent t-test was employed as statistical tool in the analysis of the data.

The study result showed significant value ($p<0.05$) under aggressive behaviour and its elements of dominant posture, biting, and boxing in the lead (Pb) exposed group as opposed to the control group, while wrestling behaviour shows no significant value ($p>0.05$).

These findings suggest that male rat aggression was provoked after the ingestion of lead (Pb). The ingestion of lead (Pb) markedly enhanced elements of aggression such as dominant posture behaviour, biting behaviour, and boxing behaviour. However, the behavioural element of wrestling was not affected. Collectively, these results suggest that the chronic ingestion of lead (Pb) would motivate aggression of the male wistar rat. Therefore, there is an urgent need for public health policies to prevent lead poisoning so as to reduce individual and societal damages and losses.

Key words: Lead(Pb), aggression, Albino Rats.

Introduction

Attempt at defining aggressive behaviour has been elusive for a while. There are many definitions as there are researchers. This is because perception and conceptualization of aggression is often influenced by the research orientation. Nevertheless, there is an agreement as to what the causal factors or influence of aggression can be which has been identified and contextual and dispositional factors. Contextual factors here mean every and any environmental stimuli that can ignite tendency to behave aggressively towards or against any given object (including human beings) or subject; while dispositional factors are to relatively enduring traits that lie within the individual which could be genetical or acquired through learning. Overall, aggression is seen as any act that was intended to cause harm or discomfort to another. However, certain individuals are likely than others to become aggressive, and the reason as to why this occurs has no doubt become a subject of controversy and debate among researchers.

Most people believe that frustration is the source of all aggressive behaviours. Although frustration is an important factor associated with aggressive tendency, others factors have been identified such as brain damage and substance (drug) intake such as alcohol consumption, cannabis, caffeine, cocaine and so on. Apart from these, it has also been identified that brain damage due to toxic metal exposure such as manganese, cadmium, aluminum and Leas (Pb) may also promote aggressive, antisocial and violent behaviours (Melvyn & Werbach, 1995). Lead (pb) exposure is known to cause learning and behavioural problems which are found in a substantial portion of juvenile delinquents. The strongest evidence to date comes from the Edinburgh Lead Study by Thompson et.al. (1989) which included over 500 children between the ages of 6 and 9. After taking about 30 possible confounding variables into account, the investigators still found a significant relationship between the log of blood lead (Pb) levels and teachers' ratings of children's behaviour on an "aggressive/antisocial" scale and on a "hyperactive" scale, but not on "neurotic" scale.

Yet many human activities involve the release of lead metals into the environmental which is inhaled, consumed or ingested *ab initio* unknowingly to them. For example, a news report from British Broadcasting Corporation on 5th October 2010 says that at least 400 children have died from lead poisoning in northern Nigeria. Report by United Nations (2010) identified the cause of this death to acute lead (Pb) poisoning from illegal processing of lead (Pb)–rich ore for gold extraction taking place inside houses and compounds in these areas. It is even reported that the lead (pb) pollution and intoxication crisis in Zamfara state is far from over and thousands more are believed to be at risk could the insurgence being reported in Zamfara state of Nigeria and other parts of the northern Nigeria be traced to their being exposed to lead in one form or the other?. However, it is no doubt that northern part of Nigeria is not the only vulnerable part of the country when it comes to lead (Pb) epidemic. Lead (Pb) epidemic is rapidly spreading across the nooks and crannies of Nigeria. To corroborate this fact, Akindele (2006) revealed that in Ilesha axis of the country, common lead (Pb) in pyrite now yielded an average model age of 550 Ma. This lead (Pb) systematics indicated that Au was derived from volcanics in Ilesha schist belt by hydrothermal leaching, transported through the same medium and deposited in the massive quartz veins as thio-complexes from which native gold was liberated through interaction of the ore fluid and spinnels in the host rock.

More so, in Sango area of Abeokuta, *Gbadebo & Taiwo* (2011) reported that water samples collected from fourteen different boreholes acrossed the town and analyzed for lead (Pb^{2+}) reveals Pb^{2+} (0.00-0.09 mg LG^{-1}), a result higher than WHO standards indicating anthropogenic infiltration of pollutants into the aquifers. Since the pollution of aquifers is serious, the obvious consequence of this is that it poses a big threat to public health when water from it is consumed without treatment. Given these facts, we do not need to search far to know that lead (Pb) epidemic is around us.

While attention is being shifted to medical care and lead (Pb) decontamination, the focus of this research study will be on the implication of lead (Pb) poisoning on certain aspect of behaviour. The end-point of lead (Pb) substance in most cases is death, yet the effects on human behaviour cannot be over-emphasized, hence, the motivation for this research study is underscored by searching out the effects of lead (Pb) on human behaviours (i.e.aggression). The link between lead (Pb) and aggression is well known based on foreign researches conducted. However, contemporary research studies on lead (Pb) are mostly done in foreign countries. Few researches on lead (Pb) have been done locally.

The majority of the observed lead (Pb) induced behaviours points to juvenile delinquency, antisocial behaviour, criminal behaviour, hyper-active behaviour and intellectual dysfunction. Very few research has however been done to explore the relationship between lead (Pb) exposure and aggressive behaviour.

Literature Review

Denno (1990) traced the behavioral patterns of 987 African-American youths from birth to age 22. She found that among the dozens of sociologic and biologic correlates of delinquency, lead (Pb) poisoning was among the strongest for male subjects. Lead-induced aggressiveness is not an entirely new notion. Parents have frequently reported a dramatic change in the behavior of children after recovery from an episode of acute lead (Pb) poisoning, with the child becoming restless, inattentive and aggressive, Needleman (2004).

Needleman et al. (1996) studied 301 primary school students and found that children with elevated bone lead (Pb) levels scored higher on the attention-deficit, aggression, and delinquency clusters of the Child Behavior Checklist after adjustment of covariates. Dietrich et al. (2001) in a birth cohort of 195 urban, inner-city adolescents recruited between 1979 and 1985, proved that prenatal lead (Pb) exposure was associated with parental reports of delinquency and aggression, and postnatal lead (Pb) exposure was associated with self-reports of delinquent acts.

Sciarillo et. al. (1992) conducted a research study to evaluate the influences of early lead poisoning on socio-emotional development whereby 201 African-American children aged 2 through 5 years were studied. In comparison with the low exposed group, the high exposed group (two consecutive blood lead (Pb) levels of 15 mg/dl^{-1} showed a higher measure of parent-reported behavioral problems, and increase in aggression.

According to the findings of a cross-sectional research study conducted by Olympio et al. (2009), in Brazil, to verify the association between dental enamel lead (Pb) levels and anti-social behavior. The study included 173 adolescents aged 14 to 18 years and their parents (*n* = 93), residents of impoverished neighborhoods in the city of

Bauru (state of São Paulo), a region with high crime rates. The covariate-adjusted odds ratios indicated that high dental enamel lead (Pb) levels were associated with increased risk of externalizing problems and of exceeding the clinical score for somatic complaints, social problems, and rule-breaking behavior. The authors concluded that exposure to high lead (Pb) levels can indeed trigger antisocial behavior, which claims for public policies to prevent lead (Pb) poisoning in the country.

Recently, Chiodo et al. (2007) have shown a relationship between BLL and neurobehavioral outcome in 7-year-old African American children. Among the studied variables, social problems, delinquent behavior and total behavior problem scores were associated with BLL ($\beta = 0.10$, $b = 0.09$ and $\beta = 0.09$; $P < 0.05$).

In a study conducted by, Liliana, et al. (2010) to evaluate conduct alterations in mice treated with small doses of lead (Pb) acetate in an experimental model of anxiety, the result show that animals exposed to low concentrations of lead (Pb) will show lack of emotive reactivity which supported the hypothesis about lead (Pb) influence on the development of antisocial and impulsive aggressive conducts. Lead (Pb) exposure at low concentrations, causes alterations in the nervous functions, which leads to a reduction of brain ability to use serotonin and dopamine, neurotransmitters directly associated with conduct disorders and aggressiveness.

Jack & Elva (2011) established that Low level exposure of lead (Pb) has been associated with several asymptomatic effects on humans, especially children whose nervous systems are still immature. The effects of lead (Pb) are particularly damaging to the developing nervous sys-tem, causing potentially irreversible learning, increased aggression and behavioural deficits in children. The researcher noted that even the CDC recommended 'safe' BPb level of 10 μg/dl, lead (Pb) has been linked to reduced cognitive func-tions, decreased attention, increased aggression and hyperactivity. In the CNS, lead (Pb) was shown to promote oxidative stress and apoptosis, as well as alter synaptic transmission properties of neurons. At the molecular level, this heavy metal was shown to alter channel properties as well as affect the expression level of numerous proteins.

Cervantes et al. (2005) tested the effects of exposure to different doses of lead (Pb) acetate (either 0, 25, 100, or 400 ppm) on the development of aggressive behavior in male golden hamsters. Pups were tested for offensive responses across puberty, as they were maturing from play fighting to adult aggression. Data show a dose-specific effect of lead (Pb) exposure on the development of aggression during puberty at doses resulting in blood levels well below 20 µg/dl. Animals exposed to 25 ppm lead (Pb) acetate were faster and performed more than twice as many attacks on intruders by late puberty. They were also twice as likely to initiate adult instead of play-fighting attacks around mid-puberty. These observations were independent of any effect on growth. Thus, exposure to low doses of lead (Pb) enhanced aggression and accelerated its maturation. As such, our data support the association between exposure to low doses of lead (Pb) and aggressive behavior in boys.

In a research study conducted by Bataineh (2011) , the effects of long term ingestion of the industrial metal salts, manganese sulfate, aluminum chloride, lead acetate and copper chloride was investigated on aggression, sexual behavior and fertility in male rat. Adult male rats ingested solutions of these salts along with drinking water at a concentration of 1000 p.p.m. for 12 weeks. Male rat aggression was also abolished after the ingestion of manganese sulfate, aluminum chloride, lead acetate and copper chloride. The ingestion of solutions of these salts markedly suppressed lateralizations, boxing bouts, fight with stud male and ventral presenting postures. Body, absolute or relative testes, seminal vesicles weights were dropped in adult male rats ingested with manganese sulfate, aluminum chloride, lead acetate and copper chloride. However, the absolute or relative preputial gland weights were not affected. Collectively, these results suggest that the long-term ingestion of manganese sulfate, aluminum chloride, lead acetate and copper chloride would have adverse effects on sexual behavior, territorial aggression, fertility and the reproductive system of the adult male rat.

Hypotheses

1. Rats treated with lead (Pb) will significantly exhibit wrestling behaviour more than rats treated with saline.

2. Rats treated with lead (Pb) will significantly exhibit biting behaviour more than rats treated with saline.

3. Rats treated with lead (Pb) will significantly exhibit dominant posture behaviour more than rats treated with saline.

4. Rats treated with lead (Pb) will significantly exhibit boxing behaviour more than rats treated with saline.

5. Lead (Pb) will significantly increases aggressive behaviour in rat treated with lead (Pb) than rats treated with Saline

Methodology
Subjects

12 male Albino rats weighing between 172 kg and 209 kg were used in this study. Different rats were used under the control and the experimental condition. The rats were housed in group of 6's in a North-West plastic breeding cages under constant temperature in a natural light-dark cycle. The rats had unlimited access to food and water from the day they were acquired up till the day the experiment ended.

Lead (Pb) Concentration and Preparation

1ml of lead (Pb) was taken from 1000 Part Per Million (ppm) stock solution of lead (Pb) and dissolved in 100ml standard volumetric flask.

This solution resulted into a stock solution of 10 ppm. 1ml of the 10 Part Par Million was taken and dissolved in 100mls. of distilled water in volumetric in 10mg.

This is therefore administered for rats in the experimental group per kilogram bodyweight.

Placebo

Distilled water was used in this research study as a placebo for rats in the control group.

Methods of Recording

The patterns of recording were adapted from Berend & Larry (1990). Elements under aggressive behaviour according to him are as shown below.

	Category	Description
Aggressive Behaviour	Boxing	Refers to the subject rearing up and pushing each other with their forepaws.
	Bite	Refers to subjects making a piercing contact with the teeth that scratch or breaks the skin of the other.
	Wrestling	Refers to wrapping around each other into a tight ball, rolling around together and biting, frequently screaming.
	Dominant Posture	Refers to subjects standing on their hind legs, with their back slightly arch, and with forelimbs thrown forward facing another rat.

Table I: adapted from Berend & Larry (1990)

Procedure

Data collection for this research involved performance of a thirty (30) days study of laboratory experiment. Out of the fourteen (14) days used for baseline observation and measurement, ten (10) days was prior to the experimental treatment, while four (4) days was sequel to experimental treatment, while the remaining sixteen (16) days was used for experimental treatments.

Resident intruder offensive model of aggression was adopted due to the fact that this model is very frequently used in psychopharmacology. It uses the resident animal's response to a nonspecific intruder (Adams, 1976; Olivier, 1977). When resident or territorial males meet an unfamiliar male intruder in their territory, heavy fighting may ensue, considered natural fighting, Blanchard & Blanchard (1977).

The attacking male performs a complete agonistic repertoire including both appetitive and consummatory behaviors Aggressive behavior in this situation may consist of Fight, bite, boxing, pushing, and dominant posture.

Immediately after acquiring the rats from the farm, they were quarantined for exactly five weeks, after which they were randomly grouped according to their weights (that is, before the commencement of base line).

The control group is made up of 6 male rats and experimental group is made up of 6 male rats.

Treatments were administered orally with the aid of oral cannular and 5 ml syringe (attached together), all rats in the experimental group were treated with Lead (Pb) solution, and those in the control group were treated with saline (distilled water solution).

Observation of aggressive behaviour was taken in alternate days. A day interval is always given between the observations to allow the rats to rest. However during the rest days, no treatment was given to either group of rat.

During baseline period, no treatment was given. Before the commencement of each day treatment the food container of each group of rats was emptied and the water feeder also removed. After, each rat was given treatment in line with their respective group and left 30 minute to give time for absorption. At the expiration of 30 minute, food was replaced back into the food container, and water feeder was also replaced. The weight of each rat was considered in administration of lead (Pb) dosage.

Observation of aggressive behaviour commences immediately at the expiration of 30 minute duration after the treatments. Rats in the experimental group were paired with rats in the control group in another bigger cage. Each rat was being observed under 3 trials, and 10 minutes each was allotted for each trial. A total of 18 trials were run per each experiment days.

Probability matrix was used to arranged the pairing.

The starting time of each day experiment was 9:00 am, and the subsequent day's process follows accordingly.

The lead (Pb) solution that was yet to be administered was always kept at room temperature.

In measuring aggression, direct observation of aggressive behaviours (such as Wrestle, bite, boxing, and dominant posture) according to resident intruder-offensive model was adopted. Rats that exhibit these behaviours and the number of time it occurs when paired with rats from another group was noted within the allotted time interval of 10 minute per trial.

A 12 column and 12 rows table was used for recording each day observation. A tally is ticked against each rat's number as it displays any of the aggressive behaviours towards rat from the other group within the allotted time interval of 10 minute.

Each rat was tail ringed. Rats in the control group were ringed from number 1 to 6, while those in the experimental group were ringed from number 7 to 12, with black permanent marker for easy identification.

After observation of aggressive behaviours in each trial, each rat is returned to their cages.

The scores of each rat were collated at the end of the experiment for statistical analysis.

Research Design

The design used is between group control/experimental randomized design and the scores gotten from experimental observation was analyzed using statistical tool of independent t- test to compare the mean of control group and experimental group to ascertain if any significant differences exists between control group and experimental group on the independent variable.

Result and Analysis

Hypothesis One: This states that rats treated with lead (Pb) will significantly exhibit dominant posture behaviour more than rats treated with saline.

Table I: Independent t-test showing the effect of lead (Pb) on dominant posture behaviour.

Group	N	X	S.D	S.Er. Mean	M. Diff.	df	t	Sig. (1-tail)	P
Lead(Pb) 10mg/kg	6	4.33	3.20	1.31	3.3	10	2.454	.017	P<.05
Saline 10mg/kg	6	1.00	.89	.37					

From table I, rats treated with lead (Pb) exhibits dominant posture behaviour more than rats treated with saline as the mean of dominant posture behaviour in the Lead (Pb) group (4.33 $\pm$ 1.31) was significantly higher at ($t_{(obs)}$ = 2.454, df=10, $P_{(1\ tail)}$ =.017, P<0.05), than the mean of dominant behaviour in the Saline group (1.00 $\pm$ .37). This implies that lead (Pb) had a significant influence on dominant posture behaviour in the stated direction and the tested hypothesis is accepted.

Hypothesis Two: This states that rats treated with lead (Pb) will significantly exhibit biting behaviour more than rats treated with saline.

Table II: Independent t-test showing the effect of lead (Pb) on biting behaviour.

Group	N	X	S.D	S.Er. Mean	M. Diff.	df	t	Sig. (1-tail)	P
Lead(Pb) 10mg/kg	6	3.50	1.23	.50	1.83	10	2.803	.0095	P<.05
Saline 10mg/kg	6	1.67	1.03	.42					

From table II, rats treated with lead (Pb) exhibit biting behaviour more than rats treated with saline as mean of biting behaviour in the Lead (Pb) group (3.50 $\pm$ 0.50) was significantly higher at ($t_{(obs)}$ = 2.803, df=10, $P_{(1\ tail)}$ =.0095, P<0.05), than the mean of biting behaviour in the Saline group (1.67 $\pm$ .42). This implies that lead (Pb) had a significant influence on biting behaviour in the stated direction and the tested hypothesis is accepted.

Hypothesis Three: This states that rats treated with lead (Pb) will significantly exhibit wrestling behaviour more than rats treated with saline.

Table III: Independent t-test showing the effect of lead (Pb) on wrestling behaviour.

Group	N	X	S.D	S.Er. Mean	M. Diff	Df	t	Sig. (1-tail)	P
Lead(Pb) 10mg/kg	6	2.83	3.92	1.60	0.16	10	.086	.467	P>.05
Saline 10mg/kg	6	2.67	2.66	1.09					

From table III, rats treated with lead (Pb) exhibit wrestling behaviour more than rats treated with saline however, the mean of wrestling behaviour in the Lead (Pb) group (2.83 ± 1.60) was not significant at ($t_{(obs)}$ = .086, df=10, $P_{(1\ tail)}$ = .467, P>0.05), than the mean of wrestling behaviour in the Saline group (2.67 ± 1.09). This implies that lead (Pb) had no significant influence on wrestling behaviour in the stated direction and the tested hypothesis is rejected.

Hypothesis Four: This states that rats treated with lead (Pb) will significantly exhibit boxing behaviour more than rats treated with saline.

Table IV: Independent t-test showing the effect of lead (Pb) on boxing behaviour.

Group	N	M	S.D	S.Er. Mean	M. Diff.	t	df	Sig. (1-tail)	P
Lead(Pb) 10mg/kg	6	5.67	5.35	2.19	4.34	1.921	10	.053	P<.05
Saline 10mg/kg	6	1.33	1.37	.56					

From table IV, rats treated with lead (Pb) exhibit boxing behaviour more than rats treated with saline as the mean of boxing behaviour in the Lead (Pb) group (5.67 ± 2.19) was significantly higher at ($t_{(obs)}$ = 1.921, df=10, $P_{(1\ tail)}$ = 0.053, P<0.05), than the mean of boxing behaviour in the Saline group (1.33 ± 0.56). This implies that lead (Pb) had a significant influence on wrestling behaviour in the stated direction and the tested hypothesis is accepted.

Hypothesis Five: This states that lead (Pb) will significantly increases aggressive behaviour in rat treated with lead (Pb) than in rats treated with Saline.

TABLE V: Independent t-test showing the effect of lead (Pb) on aggressive behaviour.

Group	N	X	S.D	S.Er. Mean	M. Diff.	df	t	Sig. (1-tail)	P
Lead(Pb) 10mg/kg	6	16.3	11.40	4.65	9.67	10	1.935	.048	P<.05
Saline 10mg/kg	6	6.7	4.46	1.82					

From table V, rats treated with lead (Pb) exhibit more aggressive behaviour than rats treated with saline as the mean of aggressive behaviour in the Lead (Pb) group (16.3 ± 4.65) was significantly higher at ($t_{(obs)}$ = 1.935, df=10, $P_{(1\ tail)}$ = .041, P<0.05), than the mean of aggressive behaviour in the Saline group (6.7 ± 1.82). This implies that lead (Pb) had a significant influence on aggression in the stated direction and the tested hypothesis is accepted.

Discussion

From the results presented in independent t-test table in the preceding section, the mean of the four behavioural elements under aggression (Dominant Posture, Bite, Wrestle, Boxing) in the experimental group were higher than those of the control group. Higher aggressive responses occurred at this level of treatments (10mg/kg) under the behavioural element of boxing followed by dominant posture, then bite, hence, it is clear that lead (Pb) exposure markedly had a positive effects on aggressive behaviour under these elements after the ingestion of lead (Pb). These contradicts the findings of Bataineh, et.al. (2011) who found out that adults male rat ingested solutions of industrial metal salts (manganese sulfate, aluminum chloride, lead acetate and copper chloride) along with drinking water at a concentration of 1000 p.p.m. for 12 weeks. Male rat aggression was also abolished after the ingestion of manganese sulfate, aluminum chloride, lead acetate and copper chloride. The ingestion of solutions of these salts markedly suppressed lateralizations, boxing bouts, fight with stud male and ventral presenting postures.

Meanwhile, hypotheses three, which states that rats treated with lead (Pb) will wrestle more than rats treated with saline was not supported by the result and this outcome is in synchrony with the outcome reported by Bataineh, et.al. (2011), that ingestion of lead (Pb) acetate markedly suppress wrestle with stud male.

Another observation made after rats were exposed to lead (Pb) was that rats exposed to lead (Pb) recorded high aggregate aggressive behaviour than rats exposed to saline. This is as depicted in the table V that tested hypothesis five which states that rats exposed to lead (Pb) will behave more aggressively than rats exposed to saline and it is supported by the result that we have in chapter four. Similar findings were reported by Ogilive & Martin (1982); Cervantes et. al., (2005); Thompson (1989); Sciarillo et. al., (1992); Needleman et. al., (1996); and Wright et. al., (2008); Denno (1990); Dietrich (2001); Byers & Lord (1943); Dwight (1976); Paul and Michael (2001)

0ur result of hypothesis five corroborates the findings of Wright et. al. (2008), who disclosed that Prenatal and postnatal blood lead (Pb) concentrations are associated with higher rates of total arrests and arrests for offenses involving violence. Supporting his view, Denno (1990) reported that parents have frequently reported a dramatic change in the behavior of children after recovery from an episode of acute lead (Pb) poisoning, with the child becoming restless, inattentive and aggressive. Also, Byers & Lord (1943), reported attention deficits and aggression in a sample of lead (Pb) poisoned children. Corroborating Wright's view point, Dietrich et. al. (2001) said that prenatal lead (Pb) exposure was associated with parental reports of delinquency and aggression, and postnatal lead (Pb) exposure was associated with self-reports of delinquent acts.

Thompson, et. al. (1989) reported that dose-response relationship was seen between increased blood lead (Pb) levels and increased (worse) aggressive/antisocial and hyperactive behavior ratings. This result support the outcome of research conducted by Dwight et. al. (1976), that low-level lead (Pb) exposure may not reliably produce hyperactivity in rodents. However, Cervantes et al. (2005) who tested the effects of exposure to different doses of lead (Pb) acetate (either 0, 25, 100, or 400 ppm) on the development of aggressive behavior in male golden hamsters concluded that exposure to low doses of lead (Pb) enhanced aggression and accelerated its maturation.

In a cross-sectional ecological study conducted by Paul & Michael, (2001), to evaluate the association between estimated air lead (Pb) concentrations and homicide rates, all counties in the contiguous 48 states of the United States were considered, and air lead (Pb) concentrations and blood lead (Pb) levels were estimated. Hence, the results of this study support recent findings that there is an association between lead (Pb) exposure and violent behaviour. Hence, this also supports the hypothesis five of this research study.

In can be concluded that Lead (Pb) exposure increases the number as well as the varieties of aggressive elements emitted. That is, it increases aggressive behavior with respect to dominant posture behaviour, biting behaviour, and boxing behaviour. These results may help explain violent behavior in adolescents exposed to low doses of lead (Dietrich et al., 2001; Needleman et al., 1996).

Recommendations

The findings from this study implies that lead (Pb) employed for various purposes should be handled with utmost carefulness because lowest toxicity dosage (10mg/kg) might have effects on different aspects of social Behaviour in human.

Considering that a healthy social tissue can be seriously harmed by lead (Pb), it is extremely important to establish public policies against lead (Pb) contamination and guarantee an adult population that is socially well balanced and productive. Hence, this is a clarion call to the importance of preventing lead (Pb) poisoning for the good of individuals and of society.

In this context, it is tempting to state that there is a high probability that many young delinquents are actually victims of lead (Pb) poisoning and not necessarily genetic or social criminals. As the Government of the Federal Republic of Nigeria focuses ample attention on decontamination of the affected areas, the outcome of this research study however put in the spotlight the needed efforts in the area of policy on the uses of lead (Pb). This research study closes with a plea for public health policies to prevent lead (Pb) poisoning in Nigeria and other developing countries, most especially the countries of Africa, such as those that have long been adopted in the United States, Europe, and Japan.

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