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RESEARCH ARTICLE

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Effects of Aluminium chloride exposure on the body weight of Wistar rats

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ABSTRACT

Aluminium compounds are used in pharmaceuticals and in water treatment processes.This study were aimed at determining and evaluating the possible effects that aluminium chloride exposure could have on the body weight of Wistar rats. Fifty Wistar rats were used for this study. They were divided into five groups: Group I was the control that received distilled water only while the other four groups II-V received 475 mg/kg, 950 mg/kg, 1,425 mg/kg and 1,900 mg/kg of aluminium chloride, respectively through oral intubation for duration of eight weeks. The weights of the Wistar rats were taken before the commencement of the experiment and after the experiment; and the results obtained was subjected to paired sample statistics (t-test) and correlations test. The results obtained were expressed as mean± SEM and level of significant were taken at P< 0.05.Our results showed that there was weight loss in aluminium treated groups when compared with control that experienced weight gain and this was statistically significant at P< 0.05. There was strong positive correlation between weight gain (increased weight) in the control group I that received only distil water and also strong correlation in weight loss (decreased weight) in the treated groups II to V. Based on our observations, we therefore conclude that aluminium chloride exposure resulted into weight loss in Wistar rats.

Key words: Effects, Exposure, Aluminium Chloride, Body Weight, Wistar Rats

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INTRODUCTION

Human exposure to Aluminium (Al) has been increasing over the decades. It appears mostly in products of food and in drinking water derived from both natural sources and treatment methods [1]. Drinking water contribution was estimated to be ranging from 3 to 8% [2, 3].

Al has for a long time been considered on an indifferent element from a toxicological point of view. However, it is unclear whether normal environmental levels of Al especially Al contained in food, exert many toxic effect without the aid of supplementary substances, in view of the fact that, the toxic effects of environmental factors are usually enhanced by their interactions with other factors [4]. Al toxicity has been well documented in the pathogenesis of many disorders in patients undergoing long term dialysis including dialysis encephalopathy [5].

Al compounds were found to possess an increased toxicity when administered parenterally rather than orally. The effect depends on the dose, the Al compound used and the particular animal model. It can show a discrepancy from death to behavioural change (memory loss), loss of weight or slight changes in Al buildup in bone [6-9].

Environmental pollution with different Al contain compound, particularly those in industrialized waste expose people to higher than normal levels of Al [10]. Particulate matters distributed by cement – producing factories

contain, high amount of Al and populations residing in the vicinity are exposed to the pollution [11]. Evidence for the contribution of Al to Alzheimer's disease (AD) remains contradictory [12, 13]. However, epidemiological studies have indicated a link between Al in drinking water and AD and a variety of human and animal studies have implicated learning and memory deficits after Al exposure [14-17].

Studies on workers exposed to Al dust in industrial environments demonstrate similar effects. [18-21]. Many researchers have found elevated Al levels to be associated with a decline in memory, attention, concentration, function of frontal lobe and lower vocabulary scores in hemodialysis patients [22].

Other severe neurological diseases, such as amyotrophic lateral sclerosis, Parkinsonism and the dementia complex of Guam, have been related to Al accumulation in the brain [23-25]. However, the role of Al in these conditions is still under considerable scientific debate.

It has been suggested that Al exposure is a risk factor for the development or acceleration of onset of Alzheimer's disease (AD) in humans [26, 27]. The precise pathogenic role of Al in AD is judged controversial and remains to be defined [28-30].

Weight is the amount or quantity of heaviness or mass; it is system of units for expressing heaviness or mass: measure of the heaviness of an object; the amount anything weighs [31]. In science and engineering, the weight of an object is usually taken to be the force on the object due to gravity [32, 33].

The most common definition of weight found in introductory physics textbooks defines weight as the force exerted on a body by gravity [32, 34]. This is often expressed in the formula $W = mg$, where W is the weight, m the mass of object, and g is denoted as gravitational acceleration.

The reason for conducting the present study was to determine and evaluate the possible effects that aluminium chloride ($AlCl_3$) exposure could have on the body weight of Wistar rats.

MATERIALS AND METHODS

This experiment was conducted in the Department of Human Anatomy, Ahmadu Bello University, Zaria, Kaduna State, Nigeria. Rules and regulations governing animal handling of Ahmadu Bello University were observed.

Experimental Animals and Sources of Aluminium Chloride: Total of fifty Wistar rats was used for this study. The ages of the Wistar rats were between eight and ten weeks. The Wistar rats were housed in steel cages maintained at good environmental conditions with adequate food, water and under good ventilation. The Wistar rats were kept back for two weeks (14days) before commencement of administration; this was to enable them to acclimatize. The $AlCl_3$ was manufactured from Fischer's Scientific Company, manufacturing Chemist-Fairlawn,N.J., U.S.A. The composition of the feed contain the following: Crude Protein- 15% (min.); Fat- 7% (max.); Crude Fibre-10% (Max.); Calcium-1.0% (min.); Available Phosphorus- 0.35% (min); Metabolisable Energy- 2550Kcal/Kg(min); other ingredients include Cereals/Grains, Vegetable Protein, Premix (Vitamins/ Minerals), Essential Amino Acids, Salt, Antioxidant, Anti-toxins and Prebiotic.

Experimental Design: The Wistar rats were divided into five groups: Group I was the control that received distil water only, Group II received 475 mg/kg Group III received 950 mg/kg Group IV received 1,425 mg/kg and Group V received 1,900 mg/kg

The administration was through oral intubation for duration of eight weeks. The weights of the Wistar rats were taken before the commencement of administration and later re-weighted after expiration of eight weeks of the experiment with the aid of weighing balance (i.e. Mettler Instrument AG., CH-8606 Greifensee-Zurich; Made in Western Germany. The weights were recorded before and after administration; and they were tested statistically using the paired samples statistics (T- test) and paired sample correlations. The probability level was set at $P < 0.05$ (95% confidence interval).

RESULTS AND DISCUSSION

Table1. Effects of Aluminium chloride on the weights of Wistar rats showing weight gain (increased weight) in the control group and weight loss (decreased weight) in the treated groups II-V.

Groups	Mean Values(g)	N	Std Deviation	Std error mean (S.E.M.)	P. value
(Control)					.000*
I Before	164.30	10	24.47	7.74	
I. After	190.80*	10	19.27	6.09	
II. Before	179.30	10	40.93	12.94	.002*
II. After	172.20*	10	39.41	12.46	
III. Before	157.00	10	38.96	12.32	.005*
III. After	151.00*	10	34.77	10.10	
IV. Before	174.11	10	34.18	11.39	.000*
IV. After	160.78*	9	31.96	10.65	
V. Before	176.56	10	40.17	13.39	.001*
V. After	162.56*	9	35.81	11.94	

**Means significant difference at P<0.05.*

Table2. Paired sample correlations of weight of Wistar rats showing very high correlation in differences between weights before and after the experiment.

Groups(G)	N	Correlations	Significance
G.I before &after	10	0.966	*.00*
G.II before &after	10	0.992	*.00*
G.III before &after	10	0.997	*.00*
G.IV before &after	9	0.985	*.00*
G.V before &after	9	0.986	*.00*

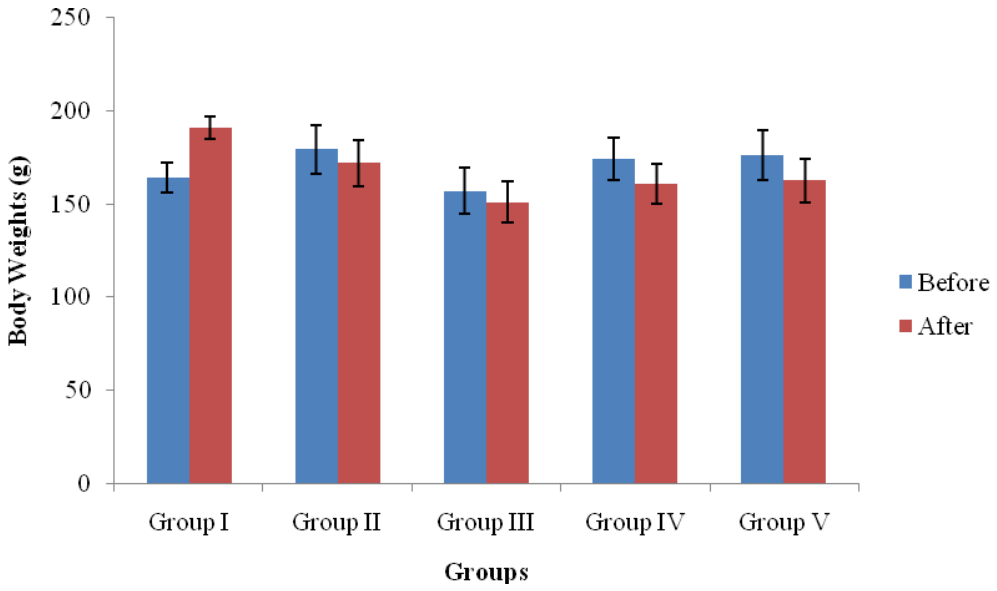

Fig.1. Effects of aluminium chloride on the body weights of both sexes (Male and Female) of wistar rats

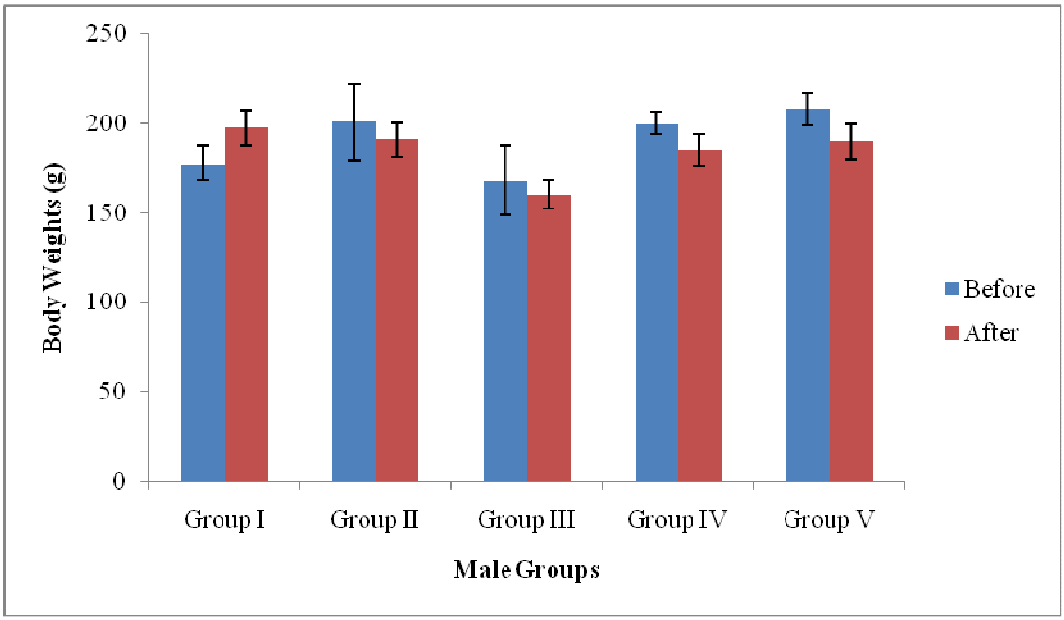

Fig.2. Effects of aluminium chloride on the body weight of male wistar rats

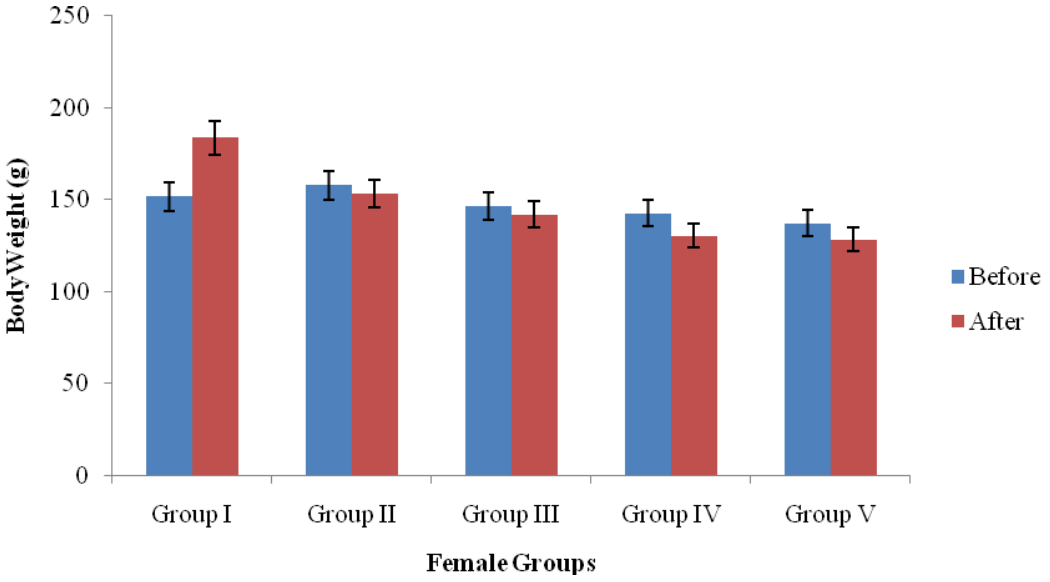

Fig.3. Effects of aluminium chloride on the body weight of female wistar rats

$AlCl_3$ was implicated to have negative effects on behavioural endpoints of Wistar rats (i.e. alters behaviour), have negative effects on anxiety-related behaviour of Wistar rats as it increased the rate of anxiety in Al treated rats, have neurodegenerative effect on the histology of cerebral cortex of adult Wistar rats especially at higher dose and had detrimental effects on the kidney of Wistar rats [35-38].

According to World Health Organization, there is little indication that Al is acutely toxic by oral exposure despite its widespread occurrence in food, drinking-water, and several antacid preparations [39]. In 1988, a population of about 20,000 individuals in Camelford, England, was exposed for no less than 5 days to unknown but increased levels of Al accidentally distributed to the population from a water supply facility using aluminium sulfate for treatment. Symptoms including vomiting, nausea, diarrhea, mouth ulcer, skin ulcers, rashes and arthritic ache were eminent. It

was concluded that the symptom were mostly mild and short-lived. There was no long-term effects on health could be ascribed to the known exposures from Al in the drinking-water [40].

Humans are uniformly exposed to Al that is present in the soil, food and drinking water [12]. $AlCl_3$ was said to have detrimental effects on the integrity of the testes and histology of the lungs of Wistar rats, which was eminent in the congested blood vessel engorged with blood, with evidence of congestion and hemorrhage. [41, 42].Al is potentially neurotoxin, though; its biological effects are not thus far well known [43]. However, another findings indicated that although, $AlCl_3$ decreased the level of sperm count, but it did not result into infertility; this they reported could be as a result of the fact that the Wistar rats that received the highest dose of $AlCl_3$ (1,900 mg kg-1) had an average sperm count of 19.75 million (10^6) which was close to 20 million sperm count required for fertility while the other treated groups had sperm count above 20 million per milliliters [44]. $AlCl_3$ exposure was reported to have no effects on the histology of the epididymis and hence storage of sperm cells (spermatozoa) by the epididymis could be safe [45]. The toxic effects of Al appear to be mediated, at least partly, by free-radical generation [46, 47].

Losing weight is always difficult but it becomes even more so the older we get. Weight loss takes a lot more effort after we turn 40years because our metabolisms start to slow down. In addition to this, our whole body – all the way down to our cells – starts to change. It doesn't help that the energy levels of a person over 40 start to drop, as does physical ability. Weight loss, in the context of medicine, health or physical fitness, is reductions of the total body mass, due to a mean loss of fluid, body fat or adipose tissue and/or lean mass, namely bone mineral deposits, muscle, tendon and other connective tissue. It can occur unintentionally due to an underlying disease or can arise from a conscious effort to improve an actual or perceived overweight or obese or state. Unintentional weight loss occurs in many diseases and conditions, including some very serious diseases such as cancer, AIDS, and a variety of other diseases. In addition to weight loss due to a reduction in fat and lean mass, fluid loss can be triggered by illnesses such as diabetes, certain medications, lack of fluid intake or other factors. Fluid loss in addition to reduction in fat and lean mass exacerbates the risk for cachexia [48].

Infections such as HIV may alter metabolism, leading to weight loss [49]. Hormonal disruptions, such as an overactive thyroid (hyperthyroidism) may also exhibit as weight loss [50]. One cutoff value of where unintentional weight loss is of significant concern is where there's a weight loss of more than 5% in the past month, or at least 10% during the last 6 months [51].

One study that assessed the effect of weight change found a prospective protective effect of beverage consumption that occurred only in participants who had previously lost weight [52].

Studies have shown that long-term consumption of caffeine [53-55], caffeinated cola [56] and caffeinated tea [57], decreases body weight in rodents. Some studies have also found decreases in adipose-pad weight [53-58] and the number of adipocytes [54], sometimes without a decrease in daily caloric intake[53,56,57].It was found that adding cola to an ad libitum Purina chow diet increased total energy intake by 50% and decreased the rate of body weight gain in rats [58].

Animal studies and prospective epidemiologic studies on weight loss [59, 60], suggest that long-term caffeine and coffee consumption could decrease body weight in humans.

The results of the present study revealed that the mean weight of Wistar rats of both sexes(male and female) in the control group before the commencement of the experiment was 164.30±7.74g which subsequently increased to 190.80±6.05g after eight weeks of administration of distil water only and the increase(weight gain) observed was statistically significant at *P=.000*. The mean weight of Wistar rats in group II before the experiment was 179.30±12.94g which was subsequently decreased to 172.20±12.46g after eight weeks of administration of 475 mg/kg of $AlCl_3$ and the decrease observed was statistically significant at *P=.002.* The mean weight of Wistar rats in group III before the experiment was 157.00±12.32g which was subsequently decreased to 151.00±10.10g after eight weeks of administration of 950 mg/kg of $AlCl_3$ and the decrease observed was statistically significant at *P=.005*. The mean weight of Wistar rats in group IV before the experiment was 174.11±11.39g which was subsequently decreased to 160.78±10.65g after eight weeks of administration of 1,425 mg/kg of $AlCl_3$ and the decrease observed was statistically significant at *P=.000*. The mean weight of Wistar rats in group V before the experiment was 176.56±13.39g which was subsequently decreased to 162.56±11.94g after eight weeks of administration of 1,900 mg/kg of $AlCl_3$ and the decrease observed was statistically significant at *P=.001(See Table 1)*.

Our results revealed that there was weight gain in the control group that received distil water only while there was significant weight loss in the Al treated Wistar rats of both sexes (table 1 and Fig.1).

In the course of the study, we lost one Wistar rat each in both group IV and V probably due to toxicity of the drug in the groups and that was why we had nine Wistar rats left in groups IV and V respectively at the end of administration of drug. We also observed that there was strong correlation between $AlCl_3$ administration and weight loss in Al treated groups II-V (Table 2).

There was statistically significant decrease in the mean body weights of the aluminium treated groups of male rats only(Fig.2) with group II having mean weight of 200.80±20.93g before administration of aluminium chloride and later decreased to 191.00±21.00g after eight weeks of aluminium chloride administration($P<0.01$).The mean weight of male wistar rats in group III was 167.60± 20.03g before commencement of administration but later decreased to160.20±18.73g after eight weeks of $AlCl_3$ administration. Group IV mean weight was 199.40± 7.34g before Al administration but later decrease to 185.20±4.95g after eight weeks of administration($P<0.05$).The mean weight for male wistar rats in group V was 208.00±9.06g before administration and later decreased to 190±9.08g after eight weeks of administration ($P<0.01$) (See Fig.2).

For the female Wistar rats only, there was decreased in the body weight in the Al treated groups after eight week of administration of $AlCl_3$ and decreased observed was only significant for group IV (Fig.3).
Our findings therefore revealed that although there are controversies about the toxicity of Al, it could be a useful tool for those interested in weight reduction (weight loss).

CONCLUSION

Based on our observations, we have a tendency to thus conclude that aluminium chloride exposure resulted into significant weight loss (reduced weight) in Wistar rats.

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