Rover Publications
United International Journal of Engineering and Sciences (UIJES)
An International Peer-Reviewed Engineering and Science Journal;Impact Factor: 5.735(SJIF)
www.uijes.com Vol-3,Issue-3 ,2022 ISSN:2582-5887

Malignant Health Challenges Associated with Trace Elements in E-Waste

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ABSTRACT

The rate at which electronic waste (e-waste) is handled in sub-Saharan Africa is alarming and it is worrisome in Nigeria because there is no legislation restricting the movement on the types of electronics that importers brings to the shore of this country and the resultant effects of the e-waste cannot be over emphasized; A closer look at computer village, Alaba international market in lagos, Computer village in Abuja, Computer and Phone section at International market in Onitsha and Nnewi one would understand increase in e-waste.

The investigators observed that the root cause of the drastic increase in the e-waste and the health challenges associated. The menace and the waiting doom that will befall the inhabitant of the fore mentioned areas, if this is not given the prompt attention the subject deserves. The study looks at the way e-waste is disposed in developed and developing countries and how best to disposed it to reduce the associated problems; most especially the health challenges it posed to humans and the ecosystem. The unsafe disposal of this e-waste; the environmental implications and human health hazards are very serious most especially to workers that have direct contacts to these dangerous materials which consist different chemicals and release of acids, toxic compounds like heavy metals, carcinogenic chemicals and indirect effects such as bioaccumulation of heavy metals.

In conclusion, the effect of e-waste cannot be completely remove from the environment as most of the known methods of managing e-waste because they are not degradable only reduces the effect to the barest. One of the methods of e-waste management is to bury in the soil in a place far from the settled area of the community and this method was found to cause pollution to the soil and water bodies as leachates from heavy metals and dioxins from plastic percolates into the water tables and the best

known method at the moment is to incinerate the waste and this is achieved through sorting of the waste to its constituent for proper handling of the waste.
There should be alegislation for the manufacturers to ensure that there are plans are in place on how to manage the waste after service life of products just like you have in Automobile manufacturers.

Keywords: Hyperbilirubinemia, Angiosarcoma, Tumorigens, Chlroacne and Communition

1.0 Introduction

The globe is a growing place that as human increases in number due to birth their activities increases; exploits in nutrition and comfort generate waste that if not well disposed poses health hazard to life and the globe as environment. The activities of homo- sapiens from nutrition to what he wears, shelter, and to comfort brings about waste. What is 'waste'? Waste is any unwanted or unusable materials. Waste is any substance that is discarded after the intended use (Wikipedia en.m.wikipedia.org(2022/06/15) Waste could also be defined as the product or materials that did not meet or useful to the beholder and it can also to be called a waste when it is not in need. The following are the various types of waste: Municipal- Solid waste, waste water (faecal and urine, kitchen and others); Hazardous waste; Mine waste; Biomedical waste; Radioactive waste; and Electronic waste (e-waste).

Trans-boundary movement of e-waste is primarily profit driven and scavengers and waste brokers takes advantage of lower recycling costs in developing economies and at the same time avoiding disposal responsibilities at home. Hence, due to the high consumer demand for the latest generation of electronics, and subsequent disposal of older electronics, the amount of e-waste being created is increasing substantially over time.

The attention on E-waste is borne out of the rise in consumption of electrical and electronics in developing economies and its health and environmental challenges. Developing countries are grossly affected because the cost of acquiring a new one as a result of high cost of purchasing new products by low and middle income earners, and unemployed individuals. Some of our business tycoon used our economic quagmire to bring obsolete electrical and electronics equipment that the developed world had faced out disposed as waste shipped them to Africans and sell to Africans. The merchant in this field employed people that work as scavengers; all they do in developed countries is to go about picking obsolete and deficient electronics that are discarded and sell to habitants in their country and after short time of usage the facility packed up and it is taken to maintenance workshop to fixed and sometimes the manufacturer has stopped the production of the parts and they become unserviceable; their owners resolved to leave it electronics at the shop of the repairer there by causing nuisance and pollution to the environment they exist.
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The e-waste is a global environmental problem and it is estimated that 75 to 80 per cent is shipped to developing countries especially in Asia and Africa like Pakistan, Bangladesh, Ghana, Nigeria and Kenya for "recycling" and disposal. Upon all of the e-waste sent for recycling in developed countries, ends up in an informal e-waste recycling sites in developing countries, basically Africa and Asia.

E-waste dumping is not new and is not limited to Nigeria; Ghana groans under the weight of 40,000 metric tonnes of imported e-waste. In 1988, Italy shipped 18,000 barrels of toxic waste marked to a village in Delta state, Nigeria.

WHO estimates that Nigeria generate N64.2billion worth of e-waste in 2019 and ranks second in Africa after Egypt. Okunola Alabi(2020) reported that many of the chemicals in electronic waste have been shown to have the potentials to cause DNA damage in both mothers and fetuses and that the bioaccumulation of heavy metals in the blood of children exposed to e-waste accompanied significant DNA change. The figure1 and 2 below show e-waste in a street:

Figure 1: Defective Refrigerators in Okpuno-Egbu,

Figure 2: Obsolete and defective Televisions

1.1 GENERATION OF E-WASTE

E-waste is any electronic or electrical appliances that are obsolete and not functional products that are discarded or electronics or electrical appliances that are obsolete or not functional which are discarded.

The term electronic waste (e-waste) or waste electrical and electronic equipment (WEEE) refers to unwanted electrical and electronic equipment that are obsolete, at the end of their lives or that have been discarded by their original users. EU WEEE Directive defined e-waste as "Electrical or electronic equipment which are wastes, including all components, sub-assemblies, and consumables, that are part of the product at the time of discarding". E-waste is prominent due to rapid technological advancement that is shortening the lifespan of the electronic products.

They are generated as a result of passé and worthlessness of the products and some of our business tycoon used our economic quagmire to bring used electrical and electronics equipment that the developed world is about to faced out and disposed as waste shipped them to Africans and sell. The merchant in this field employed people that work as scavengers; all they do in developed countries is to go about picking obsolete and deficient electronics that are discarded and sell to habitants in their country and after short time of usage the facility packed up and it is taken to maintenance workshop to fixed and sometimes the manufacturer has stopped the production of the parts and they become unserviceable; their owners resolved to leave it at the shop of the repairer there by causing nuisance and pollution to the environment they exist.

1.2 **CATEGORIES OF E-WASTE**

E-waste comprises of the electrical appliances such as fridges, air conditioners, washing machines, microwave ovens, and fluorescent light bulbs; and electronic products such as computers and accessories, mobile phones, television sets and stereo equipment. The table below shows the category of e-waste:

Table 1: ***Categories of E-waste***

E-waste category	**Some examples of products**
Temperature exchange equipment	Refrigerators, freezers, air conditioning equipment, dehumidifying equipment, heat pumps, radiators containing oil and other temperature-exchange equipment
Screens, monitors and equipment containing screens that have a surface greater than 100 cm2	Screens, televisions, liquid crystal display (LCD) photo frames, monitors, laptops, Notebooks

Large equipment (any external dimension greater than 50 cm)	Washing machines, clothes dryers, dish washing machines, cookers, electric stoves, electric hot plates, musical equipment, large printing machines, copying equipment, large medical devices, etc.
Lamps	Straight fluorescent lamps, compact fluorescent lamps, fluorescent lamps, high density discharge lamps, low pressure sodium lamps, light emitting diode (LED
Small equipment (no external dimension more than 50 cm)	Vacuum cleaners, carpet sweepers, microwaves, irons, toasters, electric knives, electric kettles, electric shavers, scales, calculators, radio sets, video cameras, video recorders, hi-fi equipment, toys, smoke detectors, etc.
Small information technology and telecommunication equipment (no external dimension more than 50 cm	Mobile phones, global positioning systems, pocket calculators, routers, personal computers, printers, telephones

Source: Sunil Herat and Agamuthu Pariatamby (2012)

1.3 Composition of e-waste

E-waste normally consists of valuables as well as potential toxic materials. The composition of e-waste is very diverse and differs in products across different categories and it thus contains more than 1000 different substances, that falls under ‘hazardous’ and ‘non-hazardous’ chemical substances. Broadly, this consists of ferrous and non-ferrous metals, plastics, glass, wood and plywood, printed circuit boards, ceramics, rubber and other items. The percentage composition is shown as follows:

- Iron and steel constitutes about 50% of these waste;
- Electrical and electronics equipment followed by plastics (21%);
- Non-ferrous metals (13%) and other constituents;
- The hazardous and toxic metals constitute about 1% of the total weight; and
- Rest of the material like precious metals constitute gold 0.1%, Silver 0.2% and palladium 0.005% respectively.

The recoverable precious metals play an important role as it gives 95% financial support to the recycling infrastructure and individual business owners in developing countries. However other metals and materials like Pb, Ni and various plastics may worth after recovery from e-waste.

However, findings from the workers in most electrical and electronic components waste recovering sites in Nigeria such as in aba in South east reveals that majority of e-waste deposited, metals constitute 60.7%, Plastics 16.1%, Metal-plastic mixture 7%, Printed Circuit Boards 3%, pollutants 2.7% etc. The percentage of heavy metals depends upon the manufacturing requirements of the equipment.

When elements such as Hg, Pb, As, Cd, Be and hexavalent Cr and flame retardants beyond threshold quantities are present in e-waste shows that such an e-waste is a hazardous waste.
The composition found in e-wastes depends strongly on factors such as:

- the type of electronic device;
- the model, manufacturer;
- date of manufacture; and
- The age of the scrap.

The above factors only work in developed countries but once they pass the trans boundary to underdeveloped or developing countries, they don't count. The entrepreneur does not think if the material is working and not the above factors or the hazardous nature. The Scraps gotten from IT and telecommunication systems contain a higher amount of precious metals than scrap gotten from household appliances. Plastics are constituents of e-waste that contains poly-brominated Di-phenyl-ethers (PBDEs),that are flame retardants.
Printed Circuit Board(PCB) found in most of the electronic devices contain arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), and other toxic chemicals. Typical printed circuit boards treated with lead solder in electronic devices contain approximately 50 g of tin-lead solder per square meter of circuit board. Obsolete refrigerators, freezers, and air conditioning units contain ozone depleting Chlorofluorocarbons (CFCs). The prominent materials such as barium, cadmium, copper, lead, zinc, and other rare earth metals are contained in end-of-life cathode ray tubes (CRTs) in computer monitors, and televisions.

2.0 Effects of E-waste on Humans and the Environment

The presence of heavy metals in e-waste made it different from municipal biodegradable waste as they not only hamper the bio-degradation process but harms the human health and environment. People engaged in e-waste treatment process are directly exposed to these metals in their line of duty are most affected. The rate of exposure to toxic is what counts and it is measured with time of exposure. The exposure above threshold limit value(TLV) to toxics is hazardous for example di-butyl phthalate and diethylhexy1phthalate are considered "Toxic for Reproduction" at concentrations >=0.5%. Europe Protection Agency(EPA) set a limit for the threshold for safe dioxin exposure at a toxicity equivalence(TEQ) of 0.7 picograms per kg of body weight per day. The limit could result in tougher and stringent limits on the amount of dioxins permitted in drinking water and air. The half life of dioxin lives is typically between 7.0-15 years (hhtps;//ehjournal.biomedcentral.com) and the daily

thermal exposure to 10-35part per million(ppm) in oil or 100-3000ppm in soil produces toxicity in animals Stephen C. Born(2016)

Most of the workers do not wear any personal protection equipment against the highly contaminated smoke that makes workers asphyxia besides the suffering from cuts and burns. It was shown from the workers that the level of trace metals, poly-brominated biphenyl ethers, high concentrations of Al, Zn, Cu, Pb, Fe, Cadmium and were found in blood sample of an e- waste patients in Lagos and poly-cyclic aromatic hydrocarbons, cadmium, chromium, nickel, iron, antimony, lead in urine sample and various arsenic species.
Globalization of e-waste has adverse environmental and health implications as developing countries face economic challenges and lack the infrastructure for sound hazardous waste management, including recycling, or effective legislation for hazardous waste management.

2.1 E-waste negative health implications

Developing countries such as Nigeria is faced with so many unemployed youths some who are graduates, school certificates and people who are looking for menial jobs sees e-waste company or factory as an opportunity where daily earning is achieved while the entrepreneur sees this as an opportunity to use innocent people to achieve a goal without proper orientation on the negative effects of e-wastes. In Nigeria more than 100,000 people work in e-waste economy as results of lack of employment opportunities. Generalization of e-waste in both developed and developing countries has created adverse environmental and public health implications as majorly developing countries faces economic quagmire and lack of infrastructure for proper handling and management of wastes that are toxic in nature. Electronic waste health challenges differ from one individual to another and their environment due to the nature of the e-waste material handling. The Pollution from e-waste when handling and processing did not only results in toxic or genotoxic on human system but also threaten the current residents and future generations living in such a geographical location. Landfilling or incinerating hazardous materials pose health risks because they contain significant amount of diverse' chemical compounds. These heavy metals and other toxins that can percolate into the soil and groundwater from landfills, diffuse into the air as a result of improper handling of incineration and it enters the human body through various medium. Inhalation of contaminated air and dust is believed to be one of the most critical pathways. Long-range transport of pollutants has also been observed, which suggests a risk of secondary exposure in remote areas. Atmospheric pollution caused by burning and dismantling activities are the major causes of occupational and secondary exposure.

The potential adverse health effects of exposure to e-waste amount to changes in lung function, thyroid function, hormonal depression, birth weight, birth outcomes, childhood growth rates, mental health, cognitive development, cytotoxicity, and genotoxity while heavy metals and halogenated compounds appear to have a major influence on public health.

Improper recycling processes and disposal methods of electronic wastes directly results in environmental degradation and negative ecosystem effects because toxic chemicals can stay in the environment for very long periods of time and will continue to increase in concentration as the amount of e-waste continues to increase most especially this new phase of technology were products are made to be used and disposed. In the course of this study it is discovered that the negative health impacts of electronics waste is malignant.

The exposure to these various hazardous elements or compounds could be through inhalation of polluted air from improper disposal, skin contact during manual dismantling and most importantly through occupational exposure at workplace. Potentially hazardous chemical elements are also components of electrical and electronic equipment; the most common are lead, cadmium, chromium, mercury, copper, manganese, nickel, arsenic, zinc, iron, and aluminum as found in most outdated e-waste send to developing countries.

Therefore, there would be more health challenges in developing countries as new and miniature electronics such as Nano- technology would come into play, that involves other new elements such as strontium, gadolinium, Strontium, cerium and titanium in electrical and electronics thereby increasing in e-waste.

The following table shows the effects of e-waste trace elements/compounds to humans and the environment

Table2: Table showing e-waste trace elements/compounds, sources and their health implication.

No	E-waste trace Elements/Compounds	Sources	Health implication
1.	Lead	CRT and solders	(a) Early symptoms of exposure are: Muscle pain; malaise; headache; and anorexia. Figure3 shows the early symptoms in humans (b) Long term and severe exposure leads to: decline in overall performance of central nervous system; genitourinary system (Nephron damage); brain tumour; hemopoietic system (Anemia); and death. Figure 4 shows long term symptoms in humans
2.	Mercury(Hg)	Electronic	(a) Short term exposure to Hg

		switches and Batteries, flat screen with fluorescent tubes.	causes: lung damage; nausea; vomiting; diarrhea; High blood pressure; skin rashes; genitourinary system (tubular dysfunction); and irritation of the eyes. (b) Long term exposure to Hg causes: total brain damage; kidneys; and Bio-accumulation of methylated Hg in living organisms concentrates through the food chain of aquatic organisms and developing foetus (embryo).
3.	Arsenic(Ar)	light emitting diodes and computer chips	Cancer (i.e. causes skin and lung cancer)
4.	Chromium(Cr)	Hardener in plastics; dyes in pigments and in coatings on some metal parts.	carcinogenic when inhaled and deoxyribonucleic acid (DNA) damage.
5.	Cadmium(Cd)	(1) Coating of contacts and switches in Computer Processing Units and monitors. (2)Nickel cadmium (NiCd) batteries.	(1) Inhaling excess of Cadmium results in lungs or diaphragm damage and death. (2) Long term exposure to low levels of Cadmium results in high blood pressure, kidney and liver damage decrease in haemoglobin, osteoporosis and cancer. Figure 5 shows the toxic effect of cadmium in the blood stream.
6.	Halogens	From insulations and plastics	Toxins like dioxins and furans are created and released during burning polluting the environment
7.	Gadolinium	Garnets in microwave, colour TV tubes,	Skin and eyes irritation, and tumorigens

		recording heads for video recorders, compact disks and computer memory.	
8.	Krypton	Photographic projection lamps, Strobo lamps, filing electric lamp bulbs and various electronic devices.	Excessive Inhalation Results in Dizziness, Nausea, Vomiting, Loss of Consciousness and Death.
9.	Bromine(Poly brominated di-phenyl ethers)	Fire retardants for plastics, electronics equipment, solvent	Hormones disruption, thyroid and neurobehavioral disease in children, inhalation and indigestion
10.	Polyvinyl Chloride(PVC)	PVC plastics for insulations of ICT cables.	Irritation of the eyes and skin mucous membranes and respiratory tract, frostbite, . It causes angiosarcoma of the liver –(Medical guidelines for Vinyl Management)
11.	Dioxin	Burning of insulation/ uncontrolled waste incineration	Short term exposure of humans to high levels of dioxins may result; Skin lesions (chloracne and patchy darkening of the skin), and altered liver function. Long term exposure: impairment of the immune system; the developing nervous system; and the endocrine system and reproductive functions. WHO
12.	Manganese(Mn)	Lithium ion batteries in laptops, phones	hallucination, forgetfulness, nerve damage, Parkinson, lung embolism and bronchitis. Longer exposure is impotent**.**
13.	Zinc(Zn)	Cathode ray tubes and coating of metals.	indigestion, inhalation, dermal contact and trans-placental.

14.	Berylium(Be)	power supply boxes-ray machines and ceramics components of electronics.	trans-placental, inhalation and indigestion.
15.	Nickel(Ni)	Batteries, Nickel plating on metals, wire and electrical parts.	carcinogenesis.
16.	Polychlorinated biphenyls	Capacitors, transformers, fluorescent lighting, electric motors, dish washer, dielectric fluids, lubricants and coolants in generators.	ingestion, dermal contact and trans-placental.
17.	Molybdenum(Mo)	Filament material in electronic and electrical applications, microwave devices, circuit inks for circuit boards and heat sink for solid state devices.	Liver dysfunction with hyperbilirubinemia, gout, knees, hands, feet pains, articular deformities and oedema of the joint areas and erythema**.**
18.	Barium(Ba)	Primarily on CRT tubes	Respiratory, cardiovascular, gastrointestinal, haematological, musculoskeletal and renal effects.
19.	Strontium(Sr)	Produce CRT tubes used in old school Television screens and computer monitors.	Lung cancer, Allergy, skin rashes, disruption of bone development, Anaemia and oxygen shortage.

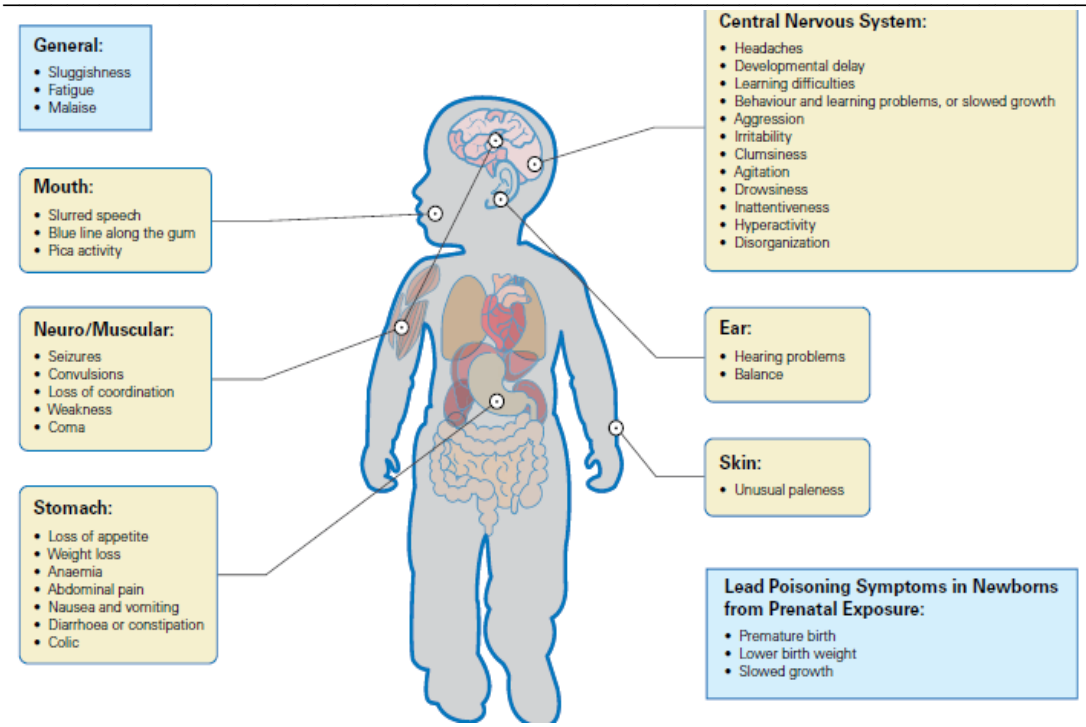

Figure 3: Stages of lead poisoning in human anatomy

Sources: Nicholas Rees and Richard Fuller (2019)

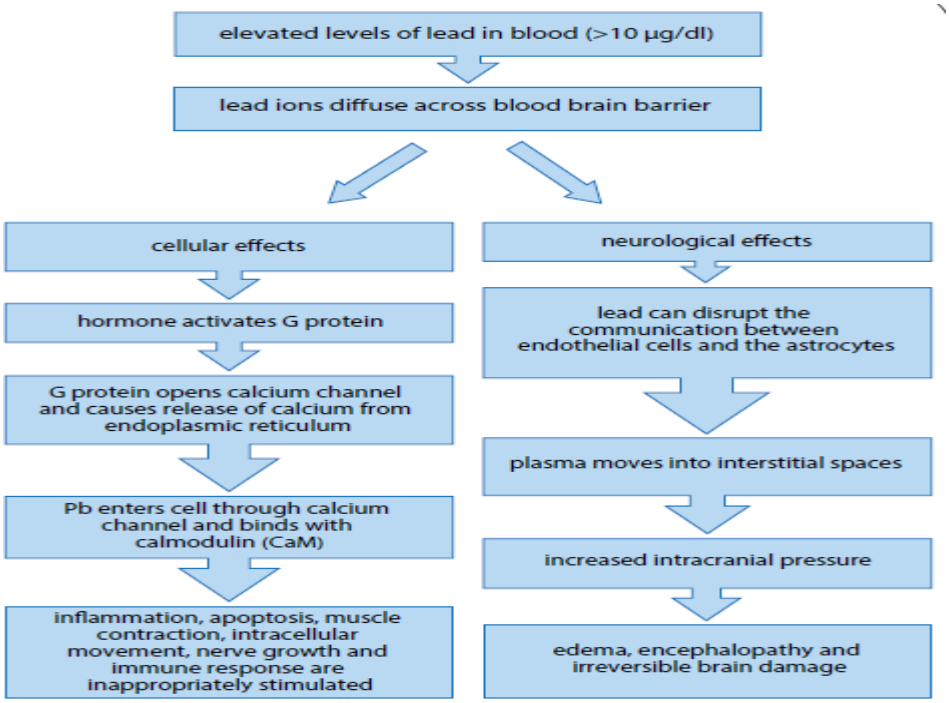

Figure 4: Stages of long term exposure effect of lead in the human system

Sources: Monisha Jaishankar et al, (2014)

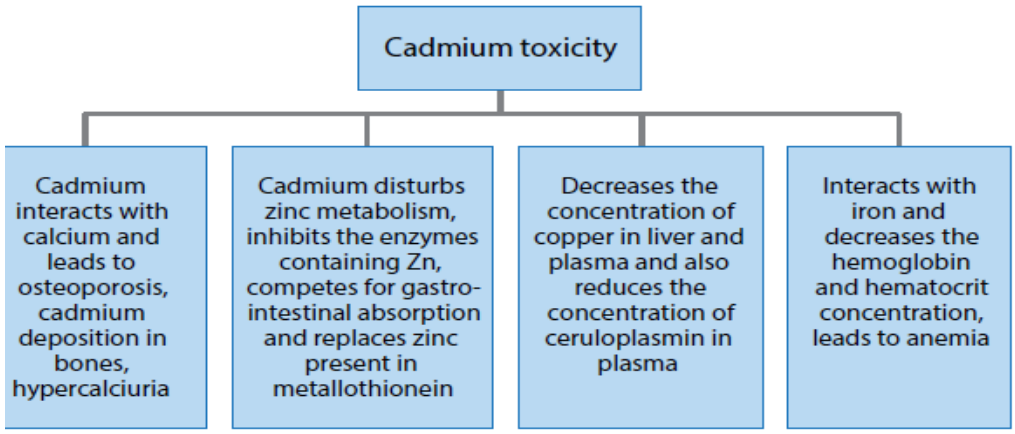

Figure5: Toxic effect of cadmium in the blood stream.
Sources: Monisha Jaishankar etal, (2014).

3.0 E- Waste disposal Systems

The trends of e-waste generation has been on the increase and its attendant effects would be on the increase too since more e-waste would be generated as predicted by Environmental Protection Agency(EPA).The causes of the increase in e-waste Having known the malignant health hazards e-waste poses to humans and ecosystems
The system of disposing e-waste presently includes:

- Incineration/open burning system
- Landfilling system and
- Acid baths system.

Special treatment of e-waste should be considered to prevent wasting valuable materials and rare E-Waste in transition from pollution to resource elements. Materials such as gold and palladium can be mined more effectively from e-waste compared to mining from their ores.

In the above methods or systems mentioned, incineration is the most common e-waste disposal system in developing countries such as African-Nigeria and during the process of incineration the following are released; pungent or poisonous fumes that are carcinogenic in nature and gases like carbon monoxide, nitrogen oxides and sulphur. During burning process, smoke contains some oxides though minor of the some of the heavy metal form residues such as antimony, thallium, copper, mercury, manganese etc. and the remainder ended up in ashes. The present trend in modern technology in developing countries such as Nigeria had results in several e-wastes existing in huge quantity at every nook and crannies where open burning of toxic e-waste, acid bath and the likes are carried out not minding the effects it cause on the environment.

There are no enacted laws by the government in most of the developing countries in African that can facilitate a compacted management of toxic e-waste. The collection, storage, reuse, recovery from e-waste and incineration and landfilling are not checkmated in developing countries because the system

of disposal is nobody's problem as each retailer, wholesaler and manufacturers mind their business including government. The recycling and recovery of materials from e-waste have become essential as they release burden on natural resources, meet the virgin material requirement, prevent the release of hazardous materials from e-waste, reduce the volume of e-waste so that the land requirement in most place may be kept minimum for further expansion.

Prior to incineration and land-filing the e-waste undergoes recycling, reuse and recovery which are other options apart from incineration as shown in figure 6 below.

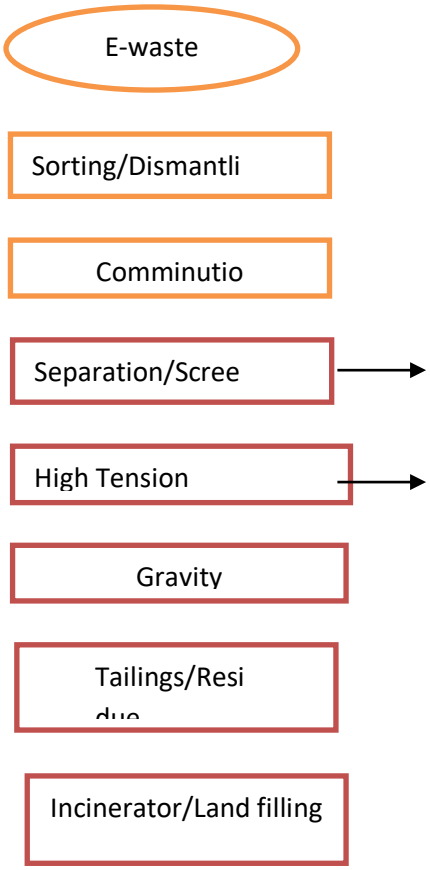

Figure 5: E-waste recycling flow chart

Conductors and non-
Conductors
Plastics

The flow chart shows the processes involved to recycle e-waste, to avoid the risk of contamination before disposal. The waste is collected through scavengers and sorting of the waste into various constituents is done manually or automatically using specific machine and followed by communition, which is the process of reducing the materials into smaller sizes using a crusher or milling machine and it is followed by separation/Screening. The screened materials is loaded into a High Tension Separator (HTS) it has two streams the conductor(Rutile, Chromite, magnetite)and non-conductors(Garnet,). It can be used to separate metals and metal, conductor and non-conductors. Here it is to separate conductive and non-conductive. The next operation is gravity/density separation it used

to separate based on the density of the materials involved and the next step is the tailings/residue. The tailing/Residue is the step where you have little valuables. Some elements are also recovered and some of stream is sent to incinerator and the others used for land filling.

The Process machines in the chart are readily available in developed Nations to recover recyclable from discarded electronic waste materials like plastics, ferrous metals, and non-ferrous metals. These methods provide a friendly environment that is free from pollution and contamination to workers involved in material selection and disposal. The efficiencies of these methods are high and vary from material to material and these methods are far behind or lacking in developing nations apart from open burning, acid baths and landfills. Hence, before importing electronics or other hazardous materials to Africa, all this method of treatment or safe disposal systems of e- waste should be check mated or have a bilateral relationship with Nigeria in general on the need to safe guide Africa on proper disposal systems or treatment technologies in order to minimize environmental threat and negative health implications to workers.

The informal recyclers used primitive and rudimentary e-waste disposal methods such as open burning for the recovery of metals: copper, aluminium, steel and put rest of the materials: plastics; PCBs; ceramics; and asbestos, that are all hazardous in nature and during incineration/ open dump burning, they explode in the atmosphere.

CONCLUSION

The study identify the mode of proliferation of the environment in the name of international business by importing second hand /used electrical or electronic gadgets into Nigeria; the gadgets after their useful service life are discarded with no regard to the pollution that it causes.

The authors proffer a solution on how best e-waste should be collected from dumpsites by scavengers and the use of Personal Protective Equipment when collecting e-waste. Nigeria has become an e-waste dumpsite for Europe, US, and Asia as result.

A desperate effort by National Environmental Standards and Regulation Enforcement Agency (NESREA) to save Nigeria of the inherent problems has enacted several laws and policies regulating the importation of used EEE. Despite the risk they pose, many African countries do not possess the right regulations or policies that would have put in place to safe guard the locality were e-waste are disposed and the people in general. This inadequate policies or regulation put not only the people handling the waste but also the environment.

The contamination from mishandling of e-waste which always degenerate constant environmental degradation should be checked so as not to only reduce the negative consequences of the environment but to also decrease the negative impact on human health from the toxic chemicals. The Proper management of electronics waste in the nearest future depends not on only government policies and its operator of recycling service but also on the relevant of community participation together with regional and global initiatives. Regulating bodies like NESREA should make it mandatory to address the occupational risks in manhandling e-waste and the effects it poses on human and the environment. Hence workers in developing countries need to be trained by an expert in e-waste handling from developed countries.

Inter-agency cooperation should be enhanced in all the countries in-order to enforce the Basel Convention's global ban on the trans-boundary movement of hazardous waste. Producers should also take their responsibility by reducing and eliminating hazardous substances in their products, producing long-lasting products which are simple to recycle and putting in place effective take-back programs.

There should be criteria for green design factors such as reducing toxicity and energy use, streamlining product weight and materials, and identifying opportunities for easier reuse of components and materials. Green design policies need to be holistically based in developing countries, looking at all aspects of electronics production, not only in greenhouse gas production or the phase-out of certain chemicals. However, to minimize potential environmental, human health and social impacts, including maximizing design for repair ability, reuse and durable use, plan for recyclability and ease of disassembly, minimize toxicity, minimize use of raw virgin materials and invest in solutions that go beyond our current dominant technologies.

The negative impact of e-waste on human environment could be eliminated through design and good selection of materials that would not generate toxic even if processed using the primitive methods such as open burning.
There should be a comprehensive approach on the exposure side (stresses) and the corresponding effects on health (strains) that is essential for an efficient occupational medical and government intervention for e-waste workers in order to improve their health and safety standard and minimise occupational hazards.

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