# THE IMPORTANCE OF DEVELOPING EXPOSURE FACTORS HANDBOOK IN NIGERIA

**Wambebe Nathaniel M[1], Xiaoli Duan[1]**

[1]*School of Energy and Environmental Engineering, University of Science and Technology Beijing, P.R.China.*

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**Abstract -** *As environmental conditions continue to change and deteriorate, the residents in African Countries such as Nigeria have become increasingly threatened by continuous exposure to contaminants in gradient concentrations but with little or no adherence to environmental regulations by the government.*

*Nigeria is also facing increase in number of potential health risk associated with environmental contamination with the UN projection on increase in population. It is now imperative that the government, regulatory bodies, and general public are aware of the dangers that contaminated air, water soil, foodstuffs, and consumer products pose to humans and the ecosystem and how to manage these risks to protect human and ecological health. As of the time of writing the paper, no Environmental regulatory agency in Nigeria has a complied data or handbook that will serve as a national index for demonstrating the physiological, nor behavioral characteristics of the Nigerian people so as to provide basic information for health risk assessment and risk management. Since Africans have unique exposure patterns and specific time-activity owing to the geological, social and economic difference, the existing Exposure Factors Handbooks in American, Europe and other countries cannot be used in evaluating risk assessment in Nigeria.*

*The paper highlights the significance of exposure factor handbook and the need for Nigeria to join list of countries with exposure factor handbook.*

***Key Words***: Activity Patterns, Exposure Factors, Environmental Policy, Environmental Regulation, Population Exposure.

## 1. INTRODUCTION

Exposure factors are related to human behavior (non-dietary ingestion rates, activity/time use patterns, consumer product use, etc.) and characteristics or anthropometric data (body weight, surface area, inhalation rate, life expectancy etc.) that help determine individual exposure to an agent in the environmental media (air, water, soil, food). They are important factors in environmental health risk assessment. [1][2]

According to Chinese Research Academy of Environmental Sciences (CRAES) 2014, Exposure factors are basic parameters used for assessing potential risk of exposure which are based on anthropometric (body weight, life expectancy), behavioral (activity/time use patterns, ingestion rate etc.) and physiological (water/food consumption rates, inhalation rate) characteristics of humans. [2]

In 1983, a risk assessment report by National Academy of Science saw the need to compile and summaries data (exposure factors) into a resource document. They recommended to the federal government to establish a regulatory agency that will enforce guidelines in order to promote consistency, technical qualities and to "ensure that the risk assessment process is maintained as a scientific effort separate from risk management". [1][2][3][4][7]

In 1989, the first Exposure Factor Handbook (EFH) was published by the United State Environmental Protection Agency (US EPA). [6] It states that EFH main purpose was to "summarize data on human behavioral and physiological characteristics that affect exposure to environmental contaminants, and provide exposure/risk assessors with recommended values that could be used to assess exposure among both adults and children". [6]

Exposure handbook is an important tool for characterizing the type and magnitude of health risk to individuals or populations from chemicals and other environmental factors thus making exposure assessment an integral part of human health risk assessment. It measures the frequency, duration, and intensity of contact of an individual with the chemical or stressor. Conduct of an exposure assessment generally requires data on exposure factors.

The roles of Exposure Factor Handbook among others are;

- Produce set of guideline for Exposure Assessment

- These Guidelines establish a "broad framework for Agency exposure assessments by describing the general concepts of exposure assessment including definitions and associated units, and by providing guidance on the planning and conducting of an exposure assessment". [23]
- This set of guidelines provide guidance on exposure assessment result presentation and also how to characterizing uncertainty. [24]
- The Guidelines discuss and reference a number of approaches and tools for exposure assessment, along with discussion of their appropriate use.

Currently, apart from the US EPA Exposure factor handbook, we have Canada Exposure Factor Handbook, Australian Exposure Factor Guide, Korean Exposure Factor Handbook, Japanese Exposure Factor Handbook, China (Exposure Factor Handbook of Chinese Population), EU ExpoFacts and some EU countries also developed theirs beside e.g. (German Exposure Factors Database, United Kingdom, the Netherlands and the Nordic countries) [1] and out of all this countries only USA, China and Korea has children's Exposure Factors Handbook.

Table 1 below shows the above listed countries and factors considered or used in their various exposure assessment. The USA EPA 2011 current edition states it main purpose as summarizing "data on human behaviors and characteristics that affect exposure to environmental contaminants and recommend values to use for these factors" [8]
The Australian Exposure Factor Guidance 2012 is intended to provide "risk assessors with sets of tabulated data on human factors that may be used as inputs to the exposure assessment component of an environmental health risk" assessment. [9]

**Table I:** List of Countries with Exposure Handbook and Factors Considered

| No. | Countries | Factors Used in the Exposure Assessment |
|---|---|---|
| 1 | USA - US EPA 2011 | Water and other select liquids Ingestion, Non-dietary ingestion factors, Soil and dust Ingestion, Inhalation rates, Dermal exposure factors, Body weight, Fruits and vegetables Intake, fish and shellfish Intake, (meats, dairy products, and fats) Intake, Grain products Intake, Home-produced foods Intake, Total food intake, Human milk intake, Activity factors, Consumer products, Lifetime, Building characteristics. |
| 2 | Australian Exposure Factor Guide | Anatomical and physiological parameters (Body weight and height) , Total and exposed skin surface area , Drinking water and food intake, Soil and incidental water ingestion (while swimming), Inhalation rate, Activity patterns (time spent indoors/outdoors, frequency of hand to mouth, ...), Inhalation and oral exposure parameters. |
| 3 | Japanese Exposure Factors Handbook | Food consumption rates, Intake of other items (e.g. cigarette, milk, soil, etc.), Food self-sufficiency rate, Time-activity patterns, Human body related factors (e.g. body weight, body surface area, breathing rate, etc.), and Others. |
| 4 | The Chinese Exposure Factors Handbook – Adult | Inhalation rate, Water ingestion rate, Food intake, Body weight, Body surface area, Time-Activity factors related to Air Exposure, Time-Activity factors related to Water Exposure, Time-Activity factors related to Soil Exposure, Time-Activity factors related to Electromagnetic Exposure, Residential factors and Life expectancy. |
| 5 | Korean Exposure Factors Handbook | Life expectancy, Body weight, Body surface area, Inhalation rate, Drinking water intake, Soil ingestion, Population mobility, Occupational mobility, Food ingestion factors, Time spent on routine activities in certain locations and in vehicles , Washing, showering, bathing and swimming. |
| 6 | 2013 Canadian Exposure Factors Handbook | Life Expectancy, Body weight, Inhalation rate, Time-Activity, Soil Ingestion, and Skin surface area |

| | | |
|---|---|---|
| 7 | EU ExpoFacts | Time-location and activity patterns (weekly work hours, daily hours at home/away, time indoors/outdoors, daily school hours, school time indoors/outdoors, outdoor recreation, shower duration), Soil and dust ingestion, Residential characteristics, Anthropometrics, Physiological Parameters (Adult body weight, Child body weight, Total skin surface area, surface area of specific body parts), Life expectancy, Employer tenure, Residential tenure, School tenure, soil adherence to skin, inhalation - short-term rate, inhalation - long-term rate, food consumption rates, home grown vegetable and fruit consumption rate, fish and shellfish consumption rate, meat and beef consumption rate, drinking water consumption rate, breast milk consumption rate. |

**Source:** Vittoria *et al.* (2014), USEPA (2011) enHealth (2012), Jae-Yeon *et al.* (2014)

It can be deduced from the above exposure factors that the most general common exposure factors are Life expectancy, Body weight, Drinking water intake, Activity pattern, Inhalation rate, Skin surface area, and Soil ingestion. This factors are the most frequently used and most essential variables in exposure or risk assessment.

## 2. NIGERIA

Nigeria, Africa's most populous country is one of the countries in West Africa on the Gulf of Guinea with a total area of 923,768 sq. km[14] making it the world's 33rd largest country in terms of area size. [15] Nigeria has a population of 190,632,261[14] making it 7th most populous country in the world. [16][17]

Nigeria has over more than 250 ethnic groups and over 500 indigenous languages; with English has the official language. The country is divided into 6 geo political zones (North West, North East, North Central, South East, South South, and South West) comprising of 36 states and the Federal Capital territory, which are further sub-divided into 774 local government areas (LGAs). The country has about 78% agricultural land and vast natural resource such as natural gas, petroleum, tin, iron ore, coal, limestone, among others. [14][21]

According to UN, 2017 World Population Prospects "Among the ten largest countries worldwide, Nigeria is growing the most rapidly. Consequently, the population of Nigeria, currently the world's 7th largest, is projected to surpass that of the United States and become the third largest country in the world shortly before 2050". [18][19]
The report said the population growth will continue to increase as a result of its high birth rate and it's expected to grow from 186million as of 2016 to 410 million in 2050. [20] With this in view, Nigeria needs to harness it vast potential to be able to sustain and boost economic development ahead of this projection.

Nigeria just like other developing countries face changelings and one of the threating challenge now is environmental problems. These problems are as a result of negligence, no adequate laws or natural disasters. Each geo political zones has different form of environmental problems, e.g. Oil spill and Gas flaring in the Niger Delta, Disforestation in the northern part of the country, burning of toxic waste and water pollution in big cities. [22]

## 3. WHY WE AS THE GIANT OF AFRICA NEED EXPOSURE FACTOR HANDBOOK (EFH)?

Nigeria face great increase in number of potential health risk associated with environmental contamination with the UN projection on increase in population, it is now imperative that the government, regulatory bodies, scientist, industrialist and general public are aware of the dangers that contaminated soil, water, air, foodstuffs, and consumer products pose to humans and the ecosystem and how to manage these risks to protect human and ecological health.

This Exposure Factor Handbook will help the government agency to have an up to date data on some of the factors to ensure that human health risk assessments are relevant, accurate and are free from uncertainty.

This paper identifies the need to develop a reliable set of exposure factors (handbooks, guidance documents) to represent the Nigerian population in order to ensure reliable risk assessment and establish at national level all relevant to the environment criteria. In line with this, for Nigeria to be able to accurately assess human health risk as a result of exposure to environmental contamination, the regulatory agency, scientist, industrialist requires current data on most of this factors like body weight, inhalation rate, time activity patterns (mostly time spent indoors or outdoors), life expectancy, and soil ingestion.

With vast variety of environmental pollutants such as waste effluent, heavy metals, agricultural run-offs, natural and synthetic chemicals etc. resulting from industrial and manufacturing activities especially in the rural and sub-urban areas of Nigeria have

been recorded to interfere with the lives of the people; contaminating waterways, agricultural produce and farm animals, blocking gutters and drainages and polluting the soil and the air. The lack of basic amenities, access to clean water and adequate medical facilities, as well as low sanitary measures in these areas, have made them target environments for contaminants and waste disposals and habitats for vectors of prevalent diseases.

Population expansion leading to increase in infrastructural activities without standard impact assessment has over time accumulated in the depletion and deterioration of the quality of the environment around the developed cities and urban areas of Nigeria, leading to crises such as excessive floods during the wet rainy seasons, claiming lives in Lagos and Benue states. The ecological effects of climate change, leading to desertification, land erosion and drought have severe impacts on food security, livelihood, socio-economic and cultural activities of the North-eastern region of Nigeria with crises resulting in the nomadic farmers migrating to other areas of the country and battling farmers for arable land for their herds to graze upon. The gross imbalance in nature in Nigeria becomes more pronounced annually with little or no laws enforced to protect animals, wildlife, sea animals and plants.

Other reasons include:

- Non-availability of baseline data
- Weak monitoring management mechanism
- Weak coordination among stakeholders
- Lack of basic tools: maps, database
- Environmental Sustainability

In line with the above, factors to be considered in the first phase of these handbook includes; Life Expectancy, Activity Pattern, Body Weight Studies, Skin Surface Area, Drinking Water Intake, Inhalation Route, Food Intake/Consumption.

## 4. NIGERIA VS. OTHER COUNTRIES WITH EXPOSURE FACTOR HANDBOOK

The Table 2 below shows a comparison of exiting data or available data on some of the Exposure Factor in Nigeria with Countries that have developed Exposure Factor Handbook

**Table 2:** Comparison of Nigeria with Countries that have developed Exposure Factor Handbook

| Exposure Factors | Nigeria | USA | Canada | Australia | Japan | Korea | China | EU |
|---|---|---|---|---|---|---|---|---|
| Time Activity Pattern | — | | √ | √ | √ | √ | √ | √ |
| Body Weight (kg) | — | √ | √ | √ | √ | √ | √ | √ |
| Inhalation Rate ($m^3/d$) | – | √ | √ | √ | √ | √ | √ | _ |
| Drinking Water Intake (ml/d) | – | √ | √ | √ | √ | √ | √ | √ |
| Food Intake (g/d) | – | √ | √ | v | √ | _ | √ | _ |
| Skin Surface Area ($cm^2$) | – | √ | √ | √ | √ | √ | √ | √ |
| Life Expectancy (years) | √a | √ | √ | √ | √ | √ | √ | √ |

**Source:** Vittoria *et al.* (2014), USEPA (2011) enHealth (2012), Jae-Yeon *et al.* (2014)

**Note:** – As of the time of writing this paper, there were not national wide accepted values of figures for the above listed factors. It is however good to know that, there are available data's but which is insignificant and might not be appropriate to use for a country with a population of over 190 million people.
**√a** – Some Data's available for this Factor

## 5. HOW WE WILL DO IT

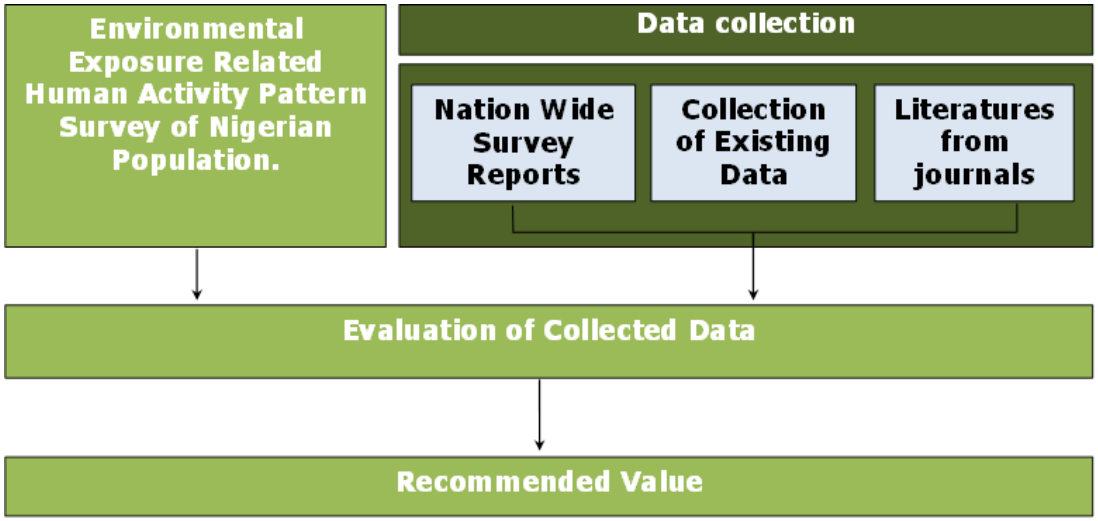


**Figure 1:** How we intend to do it.
**Source:** Wambebe Nathaniel M (2018)

## 6. CONCLUSIONS

Exposure Factor Handbook helps in providing a summarize statistical data on human exposure factors such as inhalation rates, water ingestion rates, food intake, time-activity related to exposure, body weight, surface area, life expectancy, consumer product use, and residential factors which are commonly used in exposure assessments and risk analysis.

The accuracy of the exposure factor handbook data is well essential for taken quick response towards solving some environmental problem (or attaining a certain convenience level) at low cost. To accurately assess human health risk posed by exposure to environmental contaminants, scientists and epidemiologist require current data on various factors, including body weights, skin-surface areas, and life expectancy, inhalation rates, and time-activity patterns, etc. Unlike the USA, China, Japan and the list of countries with exposure factor handbook.

No regulatory agency in Nigeria has a complied data on this information. The main aim is to provide this needed information in one place which will help serve as a national index for demonstrating the anthropometric and sociocultural data, physiological, food ingestion, and behavioral characteristics of the Nigerian people.

The Exposure factor handbook also help government and industries in setting rules and regulation on waste disposal concentrations and levels, for other research development and continuity, occupational control departments, and lastly help the resident to know their environment status in line with healthy liven.

This handbook will serve as a national index for demonstrating the physiological, food ingestion, and behavioral characteristics of the Nigerian people.

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