

## Non Communicable Diseases -The Elephant in the Room

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### ABSTRACT

Non Communicable Diseases including cardiovascular diseases, diabetes and cancer have been listed as the leading causes of death worldwide; they hamper development hence undermining the attainment development goals. Furthermore, they exacerbate social inequality. It is estimated that more than 60% of all deaths worldwide are caused by Non Communicable Diseases. NCDs had been perceived as diseases of the affluent, however, the prevalence in developing countries has increased over the years. In 2008 it was reported that four out of five NCD deaths occurred in low- and middle-income countries, an increase from what was reported earlier. According to a WHO report, NCD mortality rates in Africa are rising faster than anywhere else in the world. This paper reviews the causes, consequences and prevention strategies of NCDs.

The burden of NCDs in developing countries is driven by the negative effects of globalization, for example, unfair trade and irresponsible marketing, rapid and unplanned urbanization and increasingly sedentary lives. People in developing countries eat foods with higher levels of total energy. Increasing NCD levels are influenced by many factors including tobacco use and availability, consumption of foods high in salt, fat and sugar. A considerable proportion of global marketing targets children and adolescents as well as women in developing countries to promote tobacco smoking and consumption of 'junk' food and alcohol. Developing countries also experience rapid and unplanned urbanization which changes people's way of living through more exposure to the shared risk factors. NCDs are exacerbated in urban areas by changes in diet and physical activity, exposure to air pollutants (including tobacco smoke) and harmful use of alcohol.

NCDs are preventable and we need to talk about them everywhere and every time to help avert the menace. Lifestyle change is the panacea to NCD prevention and Management. Cessation of smoking, healthy diets and exercise are listed as some of the important strategies. Early this year the government of Rwanda declared a car free day as part of a campaign strategy for prevention of NCD. Governments must take up the elephant by its horns and sensitize people in addition to enacting legislative laws with an aim of preventing and managing the diseases. Control of these diseases will be a major milestone in achieving Sustainable Development Goals (SDG).

**Keywords:** NCDs, Development, Quality of life, Lifestyle

### INTRODUCTION

#### NON COMMUNICABLE DISEASES – GLOBAL PICTURE

Non communicable diseases (NCDs) are a global health concern. Conditions such as diabetes, cardiovascular diseases and cancer are listed as the leading of death worldwide health problem. Traditionally, NCDs were mostly the disease of developed countries, but this trend seem to be turning as we see rising levels prevalence of NCD in these developing countries (Oni and Berkowitz, 2017). According to WHO, Global Action for Prevention and Control of NCDs, 2013-2020, 57 million death

occur annually (WHO, 2013) and out of these more than 36 million people die annually from NCDs, (primarily CVDS, diabetes, cancer, and chronic respiratory diseases) accounting for 63% of global deaths. Over 80% of CVDs and diabetes deaths and close to 90% death of CORP occurred in low and middle income countries in 2008. Figure 1. (WHO, 2011; WHO, 2013).

Premature deaths are a major consideration when evaluating the impact of NCDs in the population. Premature death as a result of NCDs account for about 40% of all deaths occurring below 70 years (NCD report) and higher proportion (48%) of all NCDs premature death

## Non Communicable Diseases -The Elephant in the Room

are estimated to occur in people below 70 years in low and middle income countries compared to 29% in high income countries (WHO, 2013)

### Table1. Key points

NCDs currently cause more deaths than all other causes combined and NCD deaths are projected to increase from 38 million in 2012 to 52 million by 2030.
Four major NCDs (cardiovascular diseases, cancer, chronic respiratory diseases and diabetes) are responsible for 82% of NCD deaths.
Approximately 42% of all NCD deaths globally occurred before the age of 70 years; 48% of NCD deaths in low- and middle income countries and 28% in high-income countries were in individuals aged under 70 years.
A well-functioning civil/vital registration system is vital for monitoring progress towards attainment of global target 1.
In order to attain the premature mortality target, cost-effective policies and interventions aimed at attaining the other eight NCD targets, should be prioritized and implemented

Source: Global status report on NCDs 2014

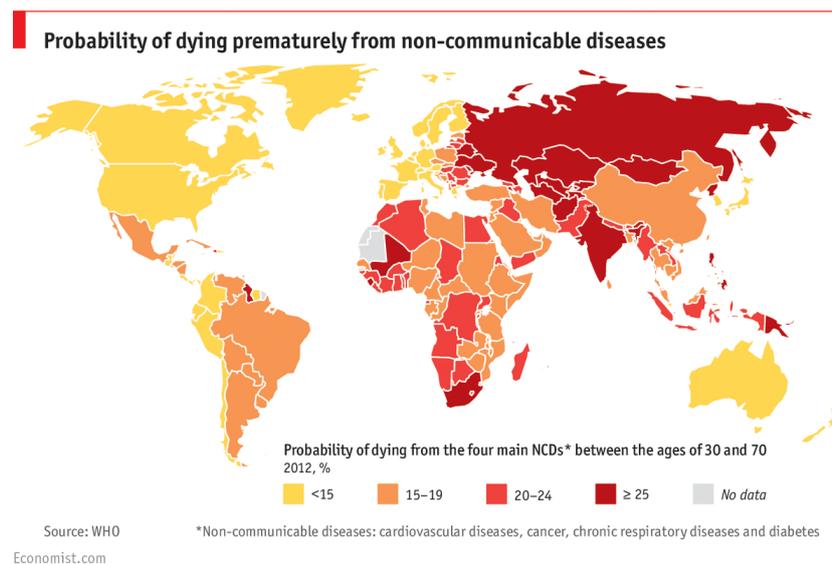


Figure1

NCDs are projected to increase by 15% globally between 2010 and 2020. Greatest increase will be in Africa, Eastern Mediterranean and South East Asia where they will increase by over 20% (WHO, 2013)

More and more people around the world are getting sick with two or more chronic conditions at the same time. For example, more people are increasingly coping with two chronic conditions, like hypertension and diabetes. This is referred to as multi-morbidity; hypertension being the most common co-morbid chronic non-communicable disease in the world (Oni and Berkowitz, 2017). An estimated one billion people live with high blood pressure (hypertension) and of these, more than nine million die due to the condition every year (Ali and Frances Xavier Gomez-Olive Casas, 2017). As the population age, NCDs are projected to rise to 52 million by 2030, while annual infectious diseases are projected to decline by about 7 million in the next 20 years (WHO,

2013). In Africa, NCDs prevalence are rising rapidly and projected to cause almost three quarters as many deaths as communicable diseases, maternal and perinatal and nutritional disorders combined by 2020 and exceed these by 2030 (WHO, 2013).

The World Health Organization (WHO) stated in 2002 that “In many regions, some of the most formidable enemies of health are joining force with allies of poverty to impose a double burden of disease, disability and premature death in many millions of people”(WHO, 2011). There is an increasing trend in developing countries where, countries are imposed with more constraints to deal with the double burden of infective and non-infective diseases in a poor environment characterized by ill-health systems. By 2020, it is predicted that these NCDs deaths will increase by 15% (44 million) where the greatest increase (20%) will be experienced in Africa, South Eastern Asia, and East

Mediterranean and no increase in the European countries (WHO, 2011).

### NCDs - AFRICA PICTURE

In Africa NCDs will cause an estimated 3.9 million deaths by 2020 (WHO, 2013). Non-Communicable diseases pattern are observed across continents and regions. According to a study by Ali and Frances Xavier Gomez-Olive Casas (2017), some parts of Africa are worse hit than others. For instance in South Africa, 50 % of people of 40-60 years suffer from Hypertension while in Burkina Faso the prevalence was found to be only 15%. Hypertension was found to be low in West Africa (15%) but higher in East Africa (25%) and highest in South Africa (42% - 54%).

There is also stark differences noted between gender, awareness and control of HBP. Studies show less men being aware of their hypertensive condition compared to women; 40% against 54%. Among the 40% of the men with the condition only 39% had controlled their blood pressure as opposed to just over half of those undergoing treatment who had controlled blood pressure (Ali and Frances Xavier Gomez-Olive Casas, 2017).

### THE BURDEN OF NCDs

Africa unlike other continents is struggling under the double health challenge: Infectious diseases and rise in NCDs. The premature death arising due to NCDs is rising, where in South Africa is more than 25% while in the rest of the continent ranges between 15-24% compared to an average of less than 15% for US and Europe (Ramsay, 2016).

The costly and prolonged treatment of NCDs raises the equity problem between countries. As expressed by the WHO Director-General in his overview to the annual report (WHO, 2003), "If a Japanese woman develop chronic diseases, excellent treatment and rehabilitation services will be available and she can expect to receive, on average, medications worth about US\$ 550 per year and much more if needed. Meanwhile, a woman in Sierra Leone can expect, on average, medicines worth about US\$ 3 per year and, if she survives middle age and develop chronic diseases then she will die prematurely as a consequence of inadequate treatment".

The contrasts in opportunities of treatment exist also between and within developing countries; between poor and rich, cities and rural areas and also between men and women.

One of the approach used to measure the global burden of NCDs is the Disability Adjusted Life Years (DALY). It is a combination of Years Life Lost (YLL); years lost through premature death and the Years Lived with Disability (YLD). The burden of adult NCDs account for 80% in developed countries and for 70% in middle-income countries. Even in the high-mortality regions of the world, almost 50% of the adult disease burden is attributable to NCDs (Boutayeb and Boutayeb, 2005). By 2020, it is predicted that NCDs will account for 80 percent of global burden of disease, causing 7 out of every 10 death in developing countries, compared to less than half today (Boutayeb and Boutayeb, 2005). WHO predict NCDs will be responsible for 3 times as many DALYs and 5 times as many deaths as communicable diseases, maternal, perinatal and nutritional conditions combined by 2030 (WHO, 2008). This is likely to put a heavy strain in the struggling health services especially in Africa, and unless the menace is dealt with concisely, Africa development and population will be adversely affected. Ischemic Heart Disease, stroke, Chronic Obstructive Pulmonary Disease (COPD) and Diabetes mellitus are among the top 15 diseases causing DALYs globally; Table 2.

The burden of disease attributable to risk factors is shown in table 3: Global DALYs Attributable to the 25 Leading Risk Factors in 1990 and 2010. The leading risk factors changed substantially, and there were major shifts in the burden of disease between 1990 and 2010. High blood pressure, tobacco smoking, diets low in fruits and vegetables, diets high in salts, obesity and NCDs are projected to increase by 15% globally between 2010 and 2020. Greatest increase will be in Africa, Eastern Mediterranean and South East Asia where they will increase by over 20% (WHO, 2013)

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## Non Communicable Diseases -The Elephant in the Room

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three quarters as many deaths as communicable diseases, maternal and perinatal and nutritional disorders combined by 2020 and exceed these by 2030 (WHO, 2013).

**Table2.** Global DALYs Caused by 25 Leading Diseases and Injuries in 1990 and 2010.

Cause	2010		1990	
	Rank	DALYs (95% UI) in thousands	Rank	DALYs (95% UI) in thousands
Ischemic heart disease	1	129,795 (119,218–137,398)	4	100,455 (96,669–108,702)
Lower respiratory tract infections	2	115,227 (102,255–126,972)	1	206,461 (183,354–222,979)
Stroke	3	102,239 (90,472–108,003)	5	86,012 (81,033–94,802)
Diarrhea	4	89,524 (77,595–99,193)	2	183,543 (168,791–197,655)
HIV–AIDS	5	81,549 (74,698–88,371)	33	18,118 (14,996–22,269)
Malaria	6	82,689 (63,465–109,846)	7	69,141 (54,547–85,589)
Low back pain	7	80,667 (56,066–108,723)	12	56,384 (38,773–76,233)
Preterm birth complications	8	76,980 (66,210–88,132)	3	105,965 (88,144–120,894)
Chronic obstructive pulmonary disease	9	76,779 (66,000–89,147)	6	78,298 (70,407–86,849)
Road-traffic injury	10	75,487 (61,555–94,777)	11	56,651 (49,633–68,046)
Major depressive disorder	11	63,239 (47,894–80,784)	15	46,177 (34,524–58,436)
Neonatal encephalopathy*	12	50,163 (40,351–59,810)	10	60,604 (50,209–74,826)
Tuberculosis	13	49,399 (40,027–56,009)	8	61,256 (55,465–71,083)
Diabetes mellitus	14	46,857 (40,212–55,252)	21	27,719 (23,668–32,925)
Iron-deficiency anemia	15	45,350 (31,046–64,616)	14	46,803 (32,604–66,097)
Sepsis and other infectious disorders in newborns	16	44,236 (27,349–72,418)	17	46,029 (25,147–70,357)
Congenital anomalies	17	38,890 (31,891–45,739)	13	54,245 (45,491–69,057)
Self-harm	18	36,655 (26,894–44,652)	19	29,605 (23,039–37,333)
Falls	19	35,406 (28,583–44,052)	22	25,900 (21,252–31,656)
Protein-energy malnutrition	20	34,874 (27,957–41,662)	9	60,542 (50,378–71,639)
Neck pain	21	32,651 (22,783–44,857)	25	23,107 (16,031–31,890)
Cancer of the trachea, bronchus, or lung	22	32,405 (24,401–38,327)	24	23,850 (18,839–29,837)
Other musculoskeletal disorders	23	30,877 (25,858–34,650)	29	20,596 (17,025–23,262)
Cirrhosis of the liver	24	31,026 (25,951–34,629)	23	24,325 (20,653–27,184)
Meningitis	25	29,407 (25,578–33,442)	18	37,822 (33,817–44,962)

\* The category of neonatal encephalopathy includes birth asphyxia and birth trauma.

**Source:** *N Engl J Med* 2013; 369:448-457

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## Non Communicable Diseases -The Elephant in the Room

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a Japanese woman develop chronic diseases, excellent treatment and rehabilitation services will be available and she can expect to receive, on average, medications worth about US\$ 550 per year and much more if needed. Meanwhile, a woman in Sierra Leone can expect, on average, medicines worth about US\$ 3 per year and, if she survives middle age and develop chronic diseases then she will die prematurely as a consequence of inadequate treatment”.

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**Table 3. Global DALYs Attributable to the 25 Leading Risk Factors in 1990 and 2010.**

Risk Factor	2010		1990	
	Rank	DALYs (95% UI) <i>in thousands</i>	Rank	DALYs (95% UI) <i>in thousands</i>
High blood pressure	1	173,556 (155,939–189,025)	4	137,017 (124,360–149,366)
Tobacco smoking, including exposure to second-hand smoke	2	156,838 (136,543–173,057)	3	151,766 (136,367–169,522)
Household air pollution from solid fuels	3	108,084 (84,891–132,983)	2	170,693 (139,087–199,504)
Diet low in fruit	4	104,095 (81,833–124,169)	7	80,453 (63,298–95,763)
Alcohol use	5	97,237 (87,087–107,658)	8	73,715 (66,090–82,089)
High body-mass index	6	93,609 (77,107–110,600)	10	51,565 (40,786–62,557)
High fasting plasma glucose level	7	89,012 (77,743–101,390)	9	56,358 (48,720–65,030)
Childhood underweight	8	77,316 (64,497–91,943)	1	197,741 (169,224–238,276)
Exposure to ambient particulate-matter pollution	9	76,163 (68,086–85,171)	6	81,699 (71,012–92,859)
Physical inactivity or low level of activity	10	69,318 (58,646–80,182)	—	—
Diet high in sodium	11	61,231 (40,124–80,342)	12	46,183 (30,363–60,604)
Diet low in nuts and seeds	12	51,289 (33,482–65,959)	13	40,525 (26,308–51,741)
Iron deficiency	13	48,225 (33,769–67,592)	11	51,841 (37,477–71,202)
Suboptimal breast-feeding	14	47,537 (29,868–67,518)	5	110,261 (69,615–153,539)
High total cholesterol level	15	40,900 (31,662–50,484)	14	39,526 (32,704–47,202)
Diet low in whole grains	16	40,762 (32,112–48,486)	18	29,404 (23,097–35,134)
Diet low in vegetables	17	38,559 (26,006–51,658)	16	31,558 (21,349–41,921)
Diet low in seafood n-3 fatty acids	18	28,199 (20,624–35,974)	20	21,740 (15,869–27,537)
Drug use	19	23,810 (18,780–29,246)	25	15,171 (11,714–19,369)
Occupational risk factors for injuries	20	23,444 (17,736–30,904)	21	21,265 (16,644–26,702)
Occupation-related low back pain	21	21,750 (14,492–30,533)	23	17,841 (11,846–24,945)
Diet high in processed meat	22	20,939 (6982–33,468)	24	17,359 (5137–27,949)
Intimate-partner violence	23	16,794 (11,373–23,087)	—	—
Diet low in fiber	24	16,452 (7401–25,783)	26	13,347 (5970–20,751)
Lead exposure	25	13,936 (11,750–16,327)	31	5,365 (4534–6279)

**Source:** *N Engl J Med* 2013; 369:448-457

One of the approach used to measure the global burden of NCDs is the Disability Adjusted Life Years (DALY). It is a combination of Years Life Lost (YLL); years lost through premature death and the Years Lived with Disability (YLD). The burden of adult NCDs account for 80% in developed countries and for 70% in middle-income countries. Even in the high-mortality regions of the world, almost 50% of the adult disease burden is attributable to NCDs

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## Non Communicable Diseases -The Elephant in the Room

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**Table3.** Evolution of NCDs in developing countries

	Non-Communicable Diseases	Communicable Diseases + Maternal + Perinatal + Nutritional	Injuries total	
1990	18.7 (47%)	16.6 (42%)	4.2 (11%)	39.5 (100%)
2000	25.0 (56%)	14.6 (33%)	5.0 (11%)	45.0 (100%)
2020	36.6 (69%)	09.0 (17%)	7.4 (14%)	53.0 (100%)

**Source:** *International Journal for Equity in Health* 2005 4:2

The burden of NCDs in developing countries is driven by negative effects of globalization for example, unfair trade and irresponsible marketing, “Westernized” lifestyle practices, rapid and unplanned urbanization and changing dietary and behavioral patterns with people eating more processed food and sugar and exercising less (Ali and Frances Xavier Gomez-Olive Casas, 2017; Oni and Berkowitz, 2017).

A study conducted in South Africa found that ½ of adverts in magazines that primarily target the poor black people were unhealthy and starchy foods (Mchiza, 2017). They pushed for sweet desserts, fast foods, hot beverages, starchy foods, sweetened foods or foods of poor nutritional value. Adverts in common channels were found to often make false health claims. Claims on food to enhance wellbeing and performance, boost immune system and as nutritionally balanced were false. The adverts emphasized on a food positive attribute such as high in fibre and vitamins while silent on the negative aspects such as energy dense, high amounts of sugar or salt and saturated fats. The vulnerable groups targeted were largely illiterate and ill-informed about health issues, and lacked money to access health information or health care and healthy foods. They therefore were less likely to be well informed to make informed judgments regarding the health claims as they were not as educated as the affluent groups. Consumptions of these products put the people of low income at risk of developing lifestyle diseases and non-communicable disease such as obesity. Poorer, unemployed South Africans

burden of disease between 1990 and 2010. High blood pressure, tobacco smoking, diets low in fruits and vegetables, diets high in salts, obesity and high fasting plasma glucose level are on the increase and pushing DALYs high.

### WHY THE INCREASE

The prevalence of NCDs is increasing at alarming rate. In 2000, NCD accounted for 56% of the total disease burden. Scientist estimate that by 2020, NCDs will account for 70% of the total disease burden in developing countries (Oni and Berkowitz, 2017) See Table 3.

were 2 times more likely to be overweight or obese compared to more affluent employed and Non-Blacks (Mchiza, 2017).

In Africa, improvement in health care and life expectancy has been observed over the recent years. As such, hypertensive older people are projected to increase to 75% in low and middle income countries by 2025 (Ali and Frances Xavier Gomez-Olive Casas, 2017). The actual burden of the disease is however poorly understood. Many people do not know that they suffer from the condition and hence do not seek treatment. The surveys done in four countries: Burkina Farsa, Ghana, Kenya and South Africa revealed that half the population are unaware of their condition and those who are aware half show poor control through treatment. There is a link between improperly treated hypertension and CVDs such as heart attacks, strokes, or kidney failure (Ali and Frances Xavier Gomez-Olive Casas, 2017). This raises questions about effectiveness of their treatment and how well they stick to drug regimen (Ali and Frances Xavier Gomez-Olive Casas, 2017). Health promotion need to be improved, but more importantly, there should be more focus on improving access to care and changing infrastructure to existing primary health care facilities to facilitate improved treatment and adherence.

Research of many years has illustrated that our health in adult life is mostly influenced by factors derived before birth; in the mother’s womb. Certain chronic conditions that manifest

in adulthood genesis in fetal stage. The so called 'Developmental Origin of Adult Diseases' hypothesis was first proposed by David Baker in collaboration with his colleagues in the early 1970s and 1980s. He worked meticulously on kept records from labor wards at Jessop Hospital for Women in Sheffield and from other units in Hertfordshire and Lancashire. His work linked increased risks of Non communicable diseases including diabetes, cardiovascular diseases and high blood pressure to poor nutrition of the mother during pregnancy. The work linked hospital records of newborn's birth weight and head and abdominal circumference with life expectancy and health in adult life. Babies with the lowest birth weight were found to have the highest levels of heart disease in later life. Similarly children of Helsinki, born between 1934 and 1944 that developed diabetes mellitus, high blood pressure in adult life were born of low birth weight and thin in the first year of life, though they caught up in growth later in their childhood (Ledger, 2011). Over time, other studies have replicated Bakers studies and apply equally on men and women and in different racial groups.

### A GENETIC LINK

Various theories have come up with mechanisms to explain the link between malnutrition *in utero* and development of NCDs later in life. **Thrifty phenotype** hypothesis is one of the most popular of such hypothesis. The theory suggests diabetes and subsequently other disorders may result to an adaptation of the fetus to persistent starvation while in the womb.

The foetus becomes permanently programmed by its response to the adverse environment while within the womb consequently changing its metabolism and cause problem in adulthood. The susceptible underweight newborns upon meeting adequate nutrition become obese soon after birth and carry this extra weight to childhood through adulthood and hence develop type 2 diabetes mellitus later in life and other conditions linked to overweight and obesity.

Extreme starvation of pregnant mothers especially in the first trimester imprints intergenerational effect of an adverse environment during pregnancy. A study conducted in Dutch during the 1944-5 of mothers who experienced extreme starvation in the first three months of pregnancy had newborn children of normal weights, but surprisingly 50 years later the female children had altered patterns of growth factor genes such as IGF-2,

and had children who were themselves smaller in the next generation (Ledger, 2011).

Lack of balanced diets during pregnancy has significantly been linked to development of chronic diseases. Even in mother who had an improved diet later in the gestation period, still produced infants of low birth weight and later suffered high blood pressure (Ledger, 2011). In a study carried out on Australian mothers indicated a third of the subjects with significantly gestational small age babies had previously been diagnosed with eating disorders. Even women who had apparently responded to treatment for their eating disorder still had a higher than expected incidence of low birth weight babies and preterm birth. However in another study in India, increase intake of fruits and vegetables was associated with increased birth weight and improved glucose tolerance in offspring (Ledger, 2011). Good nutrition undoubtedly show positive outcome and should be embraced.

Similarly, over nutrition *in utero* has deleterious effect, though this is commonly seen in the Western world in the 21<sup>st</sup> century. A new paradigm is emerging that support Developmental Origins of Health and Disease (DOHaD) (previously fetal origins hypothesis), (Hill, 2018). Both animal and human data focusing on nutrition and the environmental chemicals during development showcase how these factors acting in early development not only influences the risk of later NCDs but also potentially across several generations. DOHaD has incorporated other aspects to Bakers theory of Origin of fetal Diseases including stress, drugs and environmental pollutants, nutrition notwithstanding (Burdge & Lillycrop, 2010). These environmental influences during development have been seen to play a major role in the etiology of NCDs on susceptible individuals. DOHaD show that birth weight is not a specific predictor of NCDs. Other parameters need to be explored further. Earlier researches from early studies of environmental chemicals and diseases focusing on diethylstilbestrol, fetal alcohol syndrome, lead, and work related to fragile foetus hypothesis have shed light on the role of these factors in altering gene expression, leading to altered cell proteins, and in some instances, altered numbers and /or location of the cells (Burdge & Lillycrop, 2010)

Environmental chemicals that alter developmental plasticity often interfere with

endocrine control and so are called endocrine disrupting chemicals. The mechanism involves tissue specific and timing of the response. These work along endocrine system being sensitive to the chemical and on the timing of specific windows of development. The window of development is the period during tissue development and in some cases is mainly in utero, but in others cases such as for respiratory, immune systems and the brain is affected during childhood and even early adulthood too (Burdge & Lillycrop, 2010). But once a tissue is fully developed it is less sensitive to functional changes that can lead to increased sensitivity later in life.

More research support the association between prenatal stress and multiple diseases and disorders including CVDs such as hypertension, coronary heart disease and heart failure, and metabolic diseases such as obesity and diabetes. Stress has also been associated with neurological disease and disorders such as vasomotor problems, attention deficit, and impaired cognition and reduced brain volume in children.

The findings are proposed to arise through various mechanisms. For instance elevated levels of fetal glucocorticoids exposure, increased pro inflammatory cytokines, elevated levels of fetal serotonin or glutamate, shortened telomere length and epi genetics has been indicated for prenatal stress. These human studies are supported by findings in rodent and nonhuman primate models. However these animal and human studies indicate a marked sex differences and this makes generalization of outcomes across sex difficult (Ledger, 2011).

Consequences of prenatal stress are dependent on timing of prenatal stress during pregnancy, the type of stressors involved and uncontrollability and unpredictability of the stressors (Cotterell & Seckl, 2009). For instance early gestational stress is related to adult coronary heart disease, mid gestation to renal disease and late gestation to metabolic consequences (Cotterell & Seckl, 2009). Maternal nutrition has been implicated in NCDs as documented in many findings. In an Australian study a third of mothers who had significantly small gestational age babies had previously been diagnosed with an eating disorder. Additionally for those mothers who had received treatment for their eating disorder still had a higher than expected incidence of low birth weight babies and preterm birth (Ledger, 2011). When fetuses

of a diabetic mother are exposed to high glucose and fatty acids *in utero*, the risk of being born of high birth weight is increased and so is risk greater of developing type 2 diabetes later in life. High birth weight in female infants has also been linked to problems such as polycystic ovary syndrome and possibility of cancers in adulthood (Ledger, 2011). These fundamental homeostatic mechanisms regulating features such as blood pressure, and body size of adults being programmed during foetal life by an adverse nutritional environment is currently indisputable. The debate however is at what stage of gestation is the effects mostly occur.

Some studies indicate the first trimester is the most sensitive to these programming, while studies of IVF pregnancies suggests some aspects of programming for post natal life may be initiated as early as in the first days of embryonic life (Ledger, 2011). Whether prolonged or short nutritional impact, the results indicate a clear link between nutrition *in utero* and adult diseases.

### RECOMMENDATIONS

These studies illustrate the major roles nutrition *in utero* in addition to other environmental factors on susceptible individuals play in contributing to NCDs. In order to tackle this topical phenomenon the WHO Global Action Plan 2013-2020 offers a paradigm shift by providing a road map and menu of policy options for member states, WHO, other UN Organizations and Intergovernmental Organizations, NGOs, private sectors, which when implemented collectively a 25% relative reduction in premature mortality from NCDs among other achievements may be achieved by 2025 (WHO, 2013).

These interventions are cost effective and can be applied across countries with different economic status. Kenya is among countries that have adopted this Action Plan. Kenya proposes to achieve the objectives of Global Action Plan on prevention and control of NCDs in 3 domains; disease prevention and health promotion, early diagnosis and control of NCDs through health systems strengthening and by monitoring, surveillance and research (WHO, 2014). These measures focus more on population and less individualized.

In addition to implementation of WHO Global Action in all members' countries, Africa should have a paradigm shift from epidemiological studies and interventions to individualized

interventions to curb NCDs epidemic; that is move from epidemiology to physiology, to molecular biology and genetics. Several researches done on animals indicate response to programs is dictated by its genes. For example a study done on absorption of lycopene in human indicated that lycopene bioavailability displays a high inter-individual variability. This is because the genes we carry behave in different manner in response to food. We can promote gene expression or silence it. Many things can promote gene expression or silence gene expression such as medication, stress, environmental factors.

Animal studies have shown that a diet with little methyl-donating folate or choline before or just after birth causes certain regions of the genome to under-methylate for life. This is the genesis of Foetal Origin of Adult Diseases. A good example is the expression of *agouti* gene in mice. Once un-methylated the mice develop into obese adults and develop diabetes type 2 in adult life. However, mice with methylated *agouti* gene developed into normal mice (Dolinoy, 2008).

The future of NCDs lies with finding interventions to poor *in utero* nutrition that will be reliable and effective. Currently ultra sounds scanning are being used to assess babies not growing as expected; but this assessment come later in pregnancy and therefore does not meet the criteria of reliability and timely for effective intervention to take place. The medical science though acknowledging Bakers hypothesis do not offer any other intervention other than recommending a better nutrition and lifestyle change to mothers and mothers to be. Without doubt, improved maternal nutrition significant reduce risks of developing NCDs, but nutrigenomics offer more promise.

Other environmental factors linked to NCDs development should be further explored and guidelines offered. Currently these factors are not strongly emphasized in the Global Action Plan for the prevention and control of NCDs manual. Incorporating these factors into the WHO Action plan paradigm, would offer more research and interventions to be initiated to prevent and control NCDs and in extension, premature deaths.

In addition, understanding Africa's diverse gene pool can help fight lifestyle diseases. This is according to Michèle, Ramsay, Director of Sydney Brenner Institute for Molecular

Bioscience, professor in the Division of Human Genetics, University of Witwatersrand.

One of a key strategy being explored elsewhere is the use of genomics for precision medicine approach (Weinhold, 2006). This would create "Understanding which genetic drivers are responsible for an increased risk to a particular disease and how genetic variants in a population dictate response to treatment" (Ramsay, 2016). Once the treatment that give the largest impact is realized, therapy can be targeted more precisely a concept known as "Precision Public Health". However the challenges are enormous due to Africa's diverse genomic spectrum in addition to a wide range of different environments, cultures and levels of poverty. Though difficult, it isn't impossible.

Ramsay suggests an approach driven by research at population level with large cohorts. These would enlighten the scientists on gene-environment interactions and this would see new frontiers open up in preventing and controlling NCDs.

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## Non Communicable Diseases -The Elephant in the Room

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