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DIET, NUTRITION AND CHRONIC DISEASES:

What you eat is what you get.

By

Delana A. Adelekan
Professor of Human Nutrition

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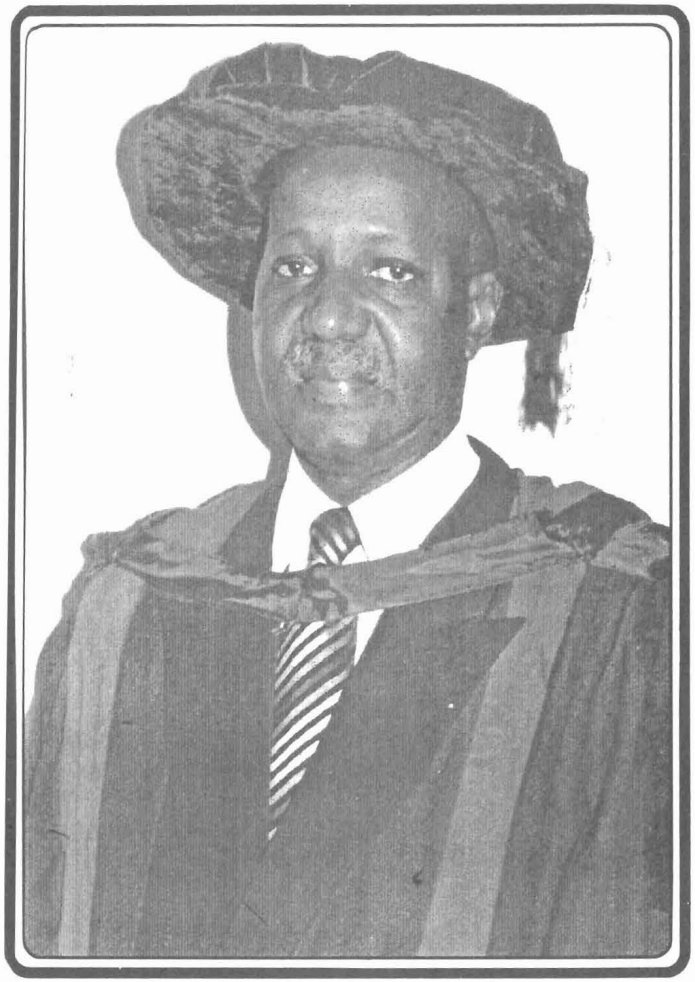

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Preamble

Mr Vice – Chancellor, distinguished guests, ladies and gentlemen. It is indeed a great honour and privilege for me to stand before this august audience today to deliver the 200th inaugural lecture of our great university – the Obafemi Awolowo University, Ile-Ife. When I assumed duty in this university on 15 September 1977 as a graduate assistant it was with the hope of staying for a few years and to then 'move on' as the saying goes. However, as Providence would have it I am still here almost 30 years later. To God be the glory.

Today's lecture is the 3rd from the Department of Community Health following after those of Professor Adeniyi-Jones in January 1978 and Professor Taiwo Daramola in April 1981 but this, Mr Vice-Chancellor, is the first lecture to inaugurate a chair of Nutrition in the College of Health Sciences of this university.

The title of today's lecture: 'Diet, Nutrition and Chronic diseases: what you eat is what you get', was chosen not just to fulfil the requirement of an inaugural lecture but more importantly for its public health value to sensitise members of this august audience and the community at large on the health implications of consuming the wrong types of diet. I will provide evidence in this lecture to confirm that indeed what diet an individual consumes determines to a very large extent what chronic disease that individual will develop.

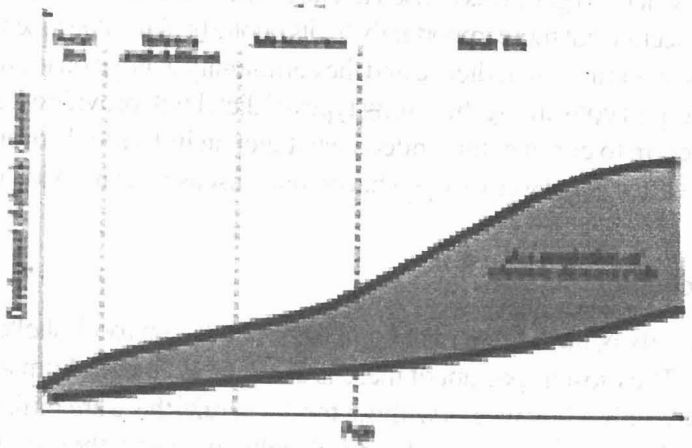
Introduction

It is generally believed that man has 3 basic needs viz: food, shelter and clothing. The most important of these is unarguably food as humans can survive for only a few weeks without food whereas there are millions of people in the world without clothing and shelter who nonetheless survive into old age. Health is influenced by a variety of factors - environmental, social and mental. One key environmental factor which is important in the promotion and maintenance of good health throughout the entire life course is diet. Diet plays a key role in the prevention of chronic diseases. It is a

matter for regret however that despite the importance of diet in the promotion and maintenance of health most individuals in both developed and developing countries pay very little attention to their diet with very serious consequences for their health. There is increasing scientific evidence supporting the view that alterations in diet have strong effects, both positive and negative, on health throughout life. Most importantly, nutritional insults inflicted on an individual early in life have been shown to determine whether or not an individual will develop such chronic diseases as cardiovascular disease, cancer and diabetes much later in life (Barker's Hypothesis – Fetal origin of adult diseases)(Barker, 1995). The risk factors for chronic diseases begin to accumulate right from foetal life and become pronounced in adulthood.

Fig. 1:

A life cause approach to chronic diseases



Source: WHO 2005

Many factors influence the development of chronic diseases such as genetic, hereditary, environmental and lifestyle factors; diet constitutes a very important factor. The risk of developing chronic diseases is substantially increased by consuming the wrong types of diet as I will show later in this lecture. Diet and nutrition are important factors in the promotion and maintenance of good health throughout the entire life course. Their role as determinants of chronic non communicable diseases is well established and they therefore occupy a prominent position in prevention activities. The chronic non communicable diseases considered in this lecture are those that are related to diet and nutrition and which present the greatest public health burden. These include obesity, diabetes, cardiovascular diseases and cancer.

The nutrition transition – from hunter-gatherer to modern diet

The past one century has witnessed rapid changes in diets and lifestyles occasioned by industrialization, urbanization, economic development and more recently market globalization. These changes have had significant impact on the health and nutritional status of populations, particularly in developing countries and in countries in transition. Obesity and diet-related chronic non communicable diseases such as diabetes and cardiovascular disease are emerging as important health concerns in developing countries including Nigeria.

This shift in dietary and lifestyle patterns is what has come to be known as the nutrition transition. The nutrition transition is characterized by increases in the consumption of fats, added sugar and animal foods and by decreases in the consumption of fruits and vegetables and fibre or complex carbohydrates. These dietary changes are in turn accompanied by decrease in physical activity.

Table 1: **Nutrient composition of traditional (hunter-gatherer) and modern (Western) diets**

	Traditional Diet	Modern/Western Diet
	% Total dietary energy	
Protein	9.0	10.0
Carbohydrate	80.0	50.0
Sugar	3.0	18.0
Starch	77.0	32.0
Total fat	11.0	40.0
P:S Ratio	1.41	0.44

Table 1 shows a comparison of the nutrient composition of traditional and modern diets. In the traditional diet, carbohydrate supplied 80% of total calories in contrast to 50% in the modern diet. Whereas, sugar supplied 3% of total dietary energy in the traditional diet, it supplies 18% of dietary energy in the modern diet most of which is refined sugar which is bad for health. The most radical departure of modern diet from the traditional diet is in the total fat content. Total fat supplied 11% of total dietary energy in the traditional diet in contrast to 40% in the modern diet with a high percentage of saturated fatty acid which is bad for health.

The introduction of food processing technology during the industrial revolution in Europe and North America altered 7 crucial nutritional characteristics of the diet of early man (i) glycaemic load (ii) fatty acid composition (iii) macronutrient composition (iv) micronutrient density (v) acid-base balance (vi) sodium-potassium ratio and (vii) fibre content (Cordain et al. 2005). Clinical and intervention studies employing diets similar in composition to those of the pre agricultural and pre industrial era have confirmed that the diet of our ancestors conferred beneficial effects

on health. Obesity, cardiovascular diseases, diabetes and cancer are rare in people consuming diets similar to those of early man (Cordain et al. 2002).

The increased incidence and prevalence of chronic non communicable diseases in affluent countries and the increasing trend in developing countries is attributable in large part to radical departures from the diet of our ancestors. In 1997 the World Health Organisation (WHO) observed that and I quote

"[Affluent populations] habitually consume a diet that was unknown to the human species a mere ten generations ago. Compared with the diet that fuelled human evolution, the so called "affluent" diet of today has twice the amount of fat, a much higher ratio of saturated to unsaturated fatty acids, a third of the former daily fibre intake, much more sugar and sodium, fewer complex carbohydrates, and a reduced intake of micro nutrients. World - wide, the adoption of this diet has been accompanied by a major increase in coronary heart disease, stroke, various cancers, diabetes and other chronic diseases" end quote.

- *'Conquering Suffering, Enriching Humanity, The World Health Report' - WHO, Geneva1997.*

Western type diets particularly 'fast foods' are becoming increasingly popular in developing countries including Nigeria. The fast food business in Nigeria is growing at an alarming rate with over 70 fast food franchises in Nigeria in 2005 with turnover in the region of N10 – 12 billion annually accounting for half of one percent (0.5%) of the Gross Domestic Product (GDP) (Falusi 2006). Fast foods may be good for the economy but they are bad for health. They are not always healthy and predispose to obesity because of the high fat content especially trans fats. Trans fats lead to an increase in the blood level of low density lipoprotein (LDL) cholesterol which is the 'bad cholesterol' and in addition lead to a decrease in the levels of high density lipoprotein (HDL) cholesterol which is the 'good

cholesterol' making trans fats even more harmful than saturated fats. Trans fats occur naturally in small quantities in meat and dairy products from ruminants. However, most trans fats consumed in diets today are industrially created as a side effect of partial hydrogenation of plant oils — a process developed in the early 1900s. Partial hydrogenation changes a fat's molecular structure thereby raising its melting point and reducing rancidity and increasing the shelf life. Margarine is made through this process.

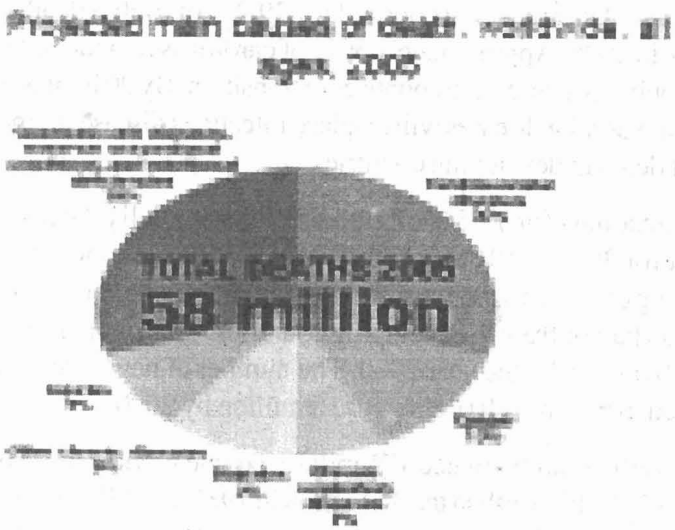
The trans fat content of fast foods is high because they are prepared with very hard industrial grade fat which is cheap. The big fast food chains in the USA and the United Kingdom (UK) have commenced the reduction of trans fats in their products and the inclusion of newer, healthier fats from soy, olive, sunflower and rapeseed oils because of the harmful effects of trans fats on health.

Global burden of chronic diseases

The burden of chronic diseases is rapidly increasing worldwide. In 2002, the World Health Organization (WHO) projected that chronic diseases would take the lives of over 35 million people in 2005 representing approximately 60% of the 58 million total projected deaths in the world in that year (WHO 2003). Almost half of the total chronic disease deaths are attributable to cardiovascular diseases. Contrary to widely held beliefs, chronic non communicable diseases are no longer peculiar to affluent countries, developing countries too are increasingly suffering from high levels of public health problems related to chronic diseases. In five out of the six regions of WHO, deaths caused by chronic diseases dominate the mortality statistics. Death from chronic diseases in the WHO Africa region was second only to that in the Eastern Mediterranean region in 2005. It has been projected that, by 2020, chronic diseases will account for almost 75% of all deaths worldwide, and that 71% of deaths due to ischemic heart disease (IHD), 75% of deaths due to stroke, and 70% of deaths due to diabetes will occur in developing countries (WHO 1998). Indeed, cardiovascular diseases are even now more numerous in India and China

than in all the economically developed countries in the world put together (WHO 2002).

Fig. 2:



Source: WHO, 2005

Currently, chronic diseases are by far the leading cause of death and disability in the world and their impact is steadily growing. The total number of people dying from chronic diseases is double that of all infectious diseases (including HIV/AIDS, tuberculosis and malaria), maternal and perinatal conditions and nutritional deficiencies put together (WHO 2005).

One billion people globally are overweight and WHO predicts that number will rise beyond 1.5 billion by 2015 without immediate action. 300 million people in the world today are obese. Obesity and overweight pose a major risk for chronic diseases including type 2 diabetes, heart disease, hypertension, stroke and certain cancers.

Cardiovascular diseases accounted for 29.2% of global deaths in 2003 and 30% in 2005. Approximately 80% of cardiovascular deaths occurred in developing countries and countries in transition. By 2010, it is projected that cardiovascular diseases will displace infectious diseases as the leading cause of death in developing countries.

Cancer accounts for 12.5% of global deaths annually. Dietary factors account for 30% of all cancers in Western countries and up to 20% in developing countries. Approximately 20 million people suffer from cancer, more than half of them in developing countries. This figure is projected to rise to 30 million by the year 2020. The number of new cases annually is estimated to rise from 10 million to 15 million by 2020.

Diabetes affects an estimated 171 million people world wide. This figure is substantially higher than the 30 million in 1985 and 135 million in 1995. The number of diabetes world wide is projected to exceed 300 million by the year 2030.

The diet in the United States of America represents the most extreme departure from the diet of our ancestors. Consequently, the adverse effects on health are most pronounced in that country. Between 2003-2004, 32.2% of adult Americans were obese and 17.1% of children aged 6-19 years were overweight (Ogden *et al.* 2006). Estimated number of deaths due to obesity in the USA was put at 284,000 in 1991 (Allison *et al.* 1999) and 111,909 in 2000 (Flegal *et al.* 2005). More than 64 million Americans have one or more types of cardiovascular disease which is the leading cause of death (38.5% of all deaths). 50 million Americans are hypertensive; 11 million have type 2 diabetes mellitus and 37 million adults maintain high risk total blood cholesterol concentrations (> 240 mg/dl)

(American Heart Association, 2004). Cancer is the second leading cause of deaths in the USA and an estimated one third of all cancer deaths are due to nutritional factors or obesity (American Cancer Society, 2004).

The situation in Nigeria is also worrying. In 2002, raised blood pressure and raised body mass index accounted for 5% and 1.5% of all deaths respectively. Deaths from chronic non communicable diseases in Nigeria in 2005 were estimated to be 478,000 representing 24% of the estimated 2,014,000 deaths in that year. Cardiovascular diseases accounted for 11% and cancer 4% of all deaths in Nigeria in the year 2005. By the year 2015, the WHO projects that over 5 million Nigerians will die of chronic non communicable diseases. (WHO 2005)

Fig. 3: Projected deaths by cause, all ages, Nigeria 2005

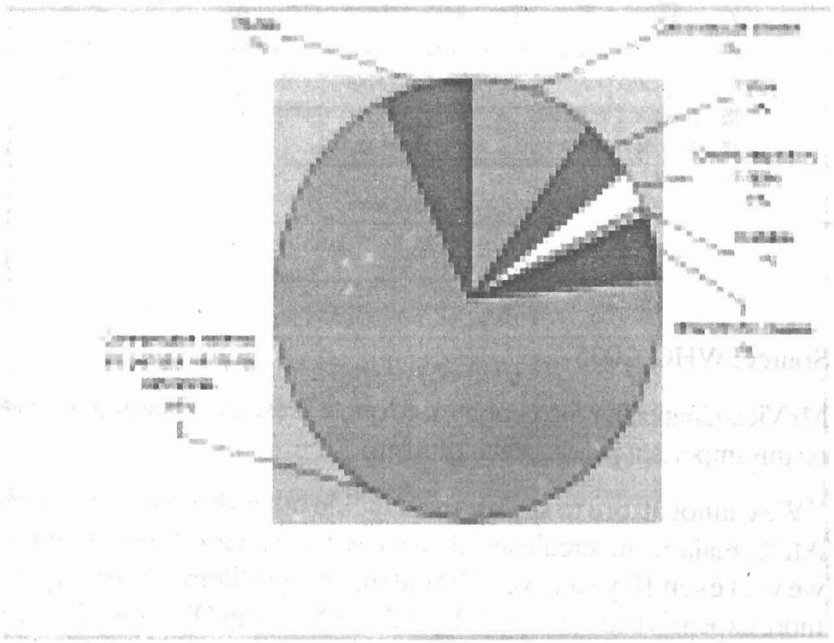
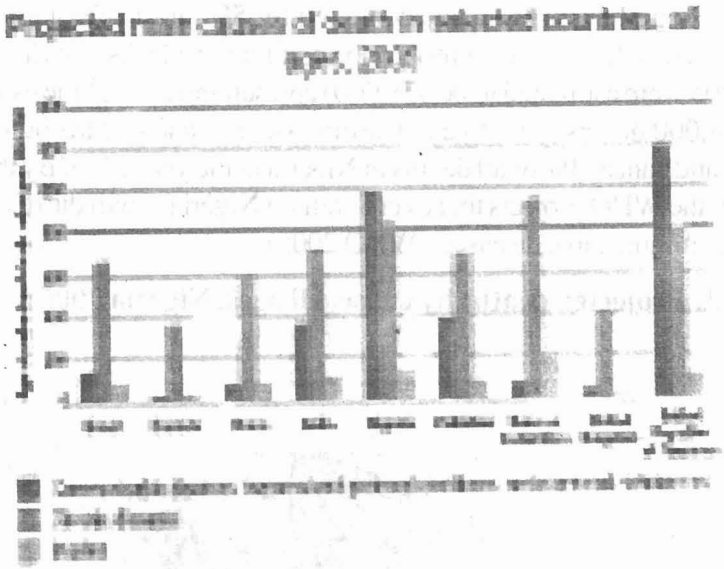


Fig 4:



Source: WHO, 2005

Mr Vice-Chancellor Sir, permit me to quote President Obasanjo's concern on this important public health problem.

''We cannot afford to say we must tackle other diseases first — HIV/ AIDS, malaria, tuberculosis - then we will deal with chronic diseases. If we wait even 10 years, we will find that the problem is even larger and more expensive to address." - President Olusegun Obasanjo, Nigeria.

Evidence Linking Diet to the development of chronic non communicable diseases

Evidence for an association between diet and chronic non communicable diseases comes from 3 main sources viz: Animal, Clinical, and Epidemiological studies. However, epidemiological studies provide the strongest evidence.

Obesity

Obesity is defined as a body mass index of 30.0 kg/m² and above. Body mass index is calculated as weight in kilograms divided by the height in meter squared (W(kg)/H(m²) and is a crude measure of population level obesity and the associated risks as shown on Table 2.

Table 2: Classification of body mass index and associated risk

Body Mass Index(kg/m²)	Classification	Risk of co-morbidities
< 18.5	Underweight	Low
18.5 – 24.9	Normal	Average
25 – 29.9	Overweight	Increased
30.0 – 34.9	Obese Class I	Moderate
35.0 – 39.9	Obese Class II	Severe
≥ 40.0	Obese Class III	Very severe

There is a paradoxical relationship between childhood malnutrition and development of obesity in later life. One form of childhood malnutrition is stunting or short stature which is a form of chronic malnutrition. Childhood stunting leads to short adult stature. Availability of more calories to an adult with short stature leads to obesity and a consequent increased risk of developing chronic diseases. In a nationwide nutrition baseline survey contracted to this university in 1993 by UNICEF and in which I participated actively as a zonal coordinator, over 60% of Nigerian children aged less

than 5 years were found to be stunted in growth. Nearer home, in a collaborative study with Professor Ojofeitimi and others in 1997, we also found that over 60% of preschool children in Atakumosa Local Government Area (LGA) were stunted in growth. Subsequent data from the Nigeria Demographic and Health Survey showed that the prevalence of stunting in preschool children in1999 was 45.0% and 38% in 2003 (NDHS, 1999, 2003). These prevalence values are still unacceptably high by comparison with more affluent countries where not more than 2% of under 5 children are stunted in growth. These data have serious implications for the health of these children in adult life as stated earlier.

There is convincing evidence that a high intake of energy-dense foods (e.g. fast foods) promotes weight gain. Similarly, a high intake of sugar-sweetened beverages is a causative factor in obesity.

On the other hand, epidemiological studies show that a high intake of dietary fibre promotes weight loss. The reduction in weight is without regard to the type of fibre or whether the fibre is consumed in food or taken as supplements.

Diabetes

Prevalence of type 2 diabetes is increasing world wide because energy intake now exceeds energy expenditure resulting in large numbers of individuals with more body fat relative to muscle mass. Both fat and muscle take up glucose from the blood in response to insulin stimulation, but the capacity of muscle in this regard far exceeds that of adipose tissue per unit weight (DeFronzo, 1997).

The association between excessive weight gain, central or abdominal adiposity and the development of type 2 diabetes is convincing. The association has been repeatedly demonstrated in longitudinal studies in different populations, with a striking gradient of risk apparent with increasing levels of Body Mass Index (BMI), adult weight gain, waist circumference or waist-to-hip ratio.

In observational epidemiological studies, a high saturated fat intake from animal sources has been associated with a higher risk of type 2 diabetes. Conversely, intake of polyunsaturated fatty acids from vegetable sources has been associated with a reduced risk of type 2 diabetes.

C. Cardiovascular Diseases (CVD)

While many other dietary, behavioural and genetic factors influence the inception and progression of coronary heart disease, elevated blood cholesterol is a paramount factor.

Evidence linking dietary fat to serum total cholesterol concentrations is incontrovertible: the prime agents are saturated and trans fatty acids. For ancestral humans the cholesterol-raising saturated fatty acids constituted about 5% of total energy intake and trans fatty acid intake was quite negligible if any. For Americans, cholesterol-raising saturated fatty acids approach 15% of dietary energy while hydrogenated vegetable fats and oils provide an unprecedented quantity of trans fats (Eaton et al. 1997).

Furthermore, both overweight and obesity and high alcohol intake contribute to an increased risk of cardiovascular disease.

High blood pressure (hypertension) is a major risk factor for coronary heart disease and stroke. Of the many risk factors associated with high blood pressure, the dietary exposure that has been most investigated is daily sodium intake. Humans are the only free-living terrestrial mammals who ordinarily consume more sodium than potassium, the only species to commonly experience rising average blood pressure with increasing age, and the only mammals to commonly develop hypertension. All available data show convincingly that sodium intake is directly associated with blood pressure. The WHO recommends a daily sodium intake of 1.7g equivalent to about 5g of salt from all sources (WHO 2002).

Numerous ecological and prospective studies have reported a significant protective association for coronary heart disease and stroke with consumption of fruits and vegetables. Consumption of fish, fish oil and

foods high in potassium (e.g sweet potato, plantains, bananas, fruit juices etc) is also associated with reduced risk of cardiovascular diseases.

CANCER

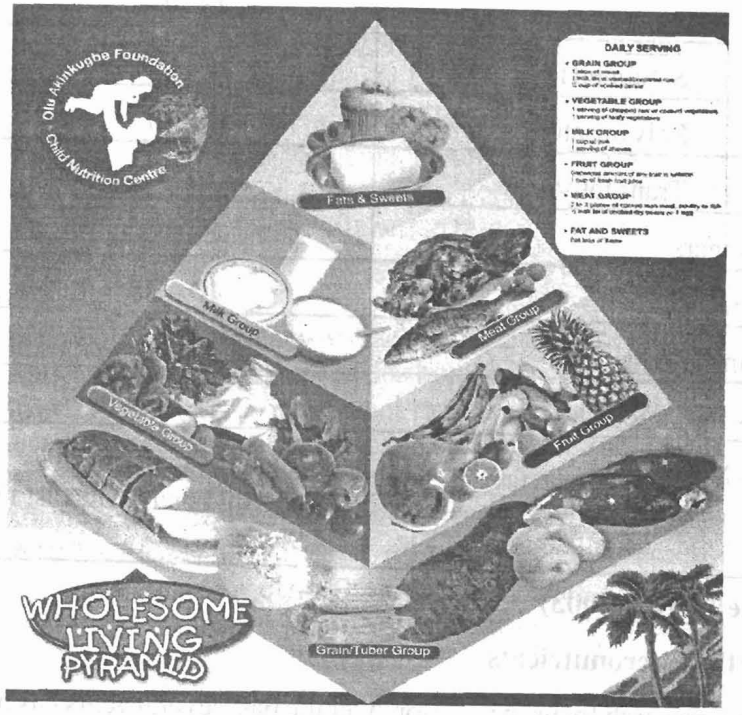
There is convincing evidence to show that overweight and obesity increase the risk of cancer of the oesophagus, colorectum, breast, endometrium and kidney. Similarly, habitual consumption of salted or fermented fish as is the practice in China is associated with cancer of the nasopharynx. Alcohol consumption is associated with an increased risk of cancer of the oral cavity, pharynx, larynx, oesophagus, liver and breast. Aflatoxins, which are secondary metabolites of moulds or fungi growing on contaminated food products stored under conditions of high temperature and humidity such as exist in tropical and subtropical countries, have also been shown to increase the risk of cancer of the liver. Dietary factors are only second to tobacco as avoidable causes of cancer.

As with other chronic non communicable diseases, the risk of cancer is reduced by the consumption of fruits and vegetables. Available evidence suggests that fruits and vegetables have far more cancer-preventing potential than do cereal grains. This probably reflects the phytochemical content of fruits and vegetables, phytochemicals to which current human biology became adapted through many million years of evolutionary interrelationships.

Preventing chronic diseases: Dietary guidelines

Mr Vice-Chancellor Sir, distinguished ladies and gentlemen, as stated earlier in this lecture, most of the chronic non communicable diseases of modern man arose because of departure from the diet of our ancestors. The hunter-gatherer or Paleolithic diet being the diet consumed by various human species for a period of 2 million years is believed to be the 'ideal diet' for man. Therefore, to reverse the trend of rising incidence of chronic non communicable diseases, man must return to the diet to which his genes have been accustomed for over 2 million years. The food guide pyramid shown below summaries what needs to be done. It is advisable to eat more of the food items at the base of the pyramid and to decrease intake of food items nearer the top of the pyramid.

Fig 5: Food Guide Pyramid



Source: Olu Akinkugbe Foundation

A healthy diet is one composed of nutrients contributing not more than the percentage of total energy shown on Table 3. A daily intake of 400g or more of fruits and vegetables is also beneficial to health but sadly we in Nigeria do not consume enough of them in spite of their abundance in our country. Fruits and vegetables contain essential vitamins and minerals needed for proper functioning of the body and for protection against diseases. Carotenes present in green leafy vegetables and coloured fruits and vegetables act as antioxidants which neutralize the effects of disease causing free radicals.

Table 3: Ranges of population nutrient intake goals

Nutrient	% Energy
Total fat	15-30
Saturated fats	< 7.0
Poly unsaturated fats	6 – 10
Trans fatty acids	< 1.0
Free sugars	< 10.0
Protein	10 – 15
Sodium chloride	< 5.0
Fruits and vegetables	e" 400g/day
Body Mass Index	Population (adult) mean – 21.0kg/m² For individuals: 18.5-24.9kg/m²

Source: WHO (2003)

Enter the Micronutrients

My own research focus in nutrition over the past several years has been on micronutrients, those chemical substances which are found in small quantities in food and which are required in small amounts in the body but whose deficiencies result in severe impairment to human health. I have carried out research work on micronutrients such as riboflavin, vitamin A, vitamin E, Ascorbic acid, iron, copper and zinc, in both laboratory animals and human subjects. My research work on humans have been in patients with protein energy malnutrition (PEM), malaria, sickle cell disease, cataracts and in pregnant women and in normal mother-child pairs.

Animal studies

My early research work on micronutrients was on the water soluble vitamin B2 or riboflavin. Riboflavin is found in significant quantities in green leafy vegetables, yeast, meat etc. Riboflavin is required for growth and metabolism. Clinical observations had shown that anaemia was common in riboflavin deficient individuals but the underlying mechanism was not well understood. At the Department of Human Nutrition, London School of Hygiene and Tropical Medicine, I worked with the riboflavin group headed by Professor David Thurnham. For my Masters and Doctorate degree programmes, I was assigned to research on iron metabolism in riboflavin deficiency as part of the group's effort to understand the anaemia of riboflavin deficiency. Using laboratory rats, I was able to show that indeed riboflavin deficiency resulted in impairment of iron metabolism. Specifically, our studies showed that both absorption and storage of iron were impaired in riboflavin deficient rats (Adelekan & Thurnham 1986a) which could be extrapolated to explain the anaemia observed in riboflavin deficient humans. However, when experimental rats were deprived of both riboflavin and iron to simulate human situations, riboflavin deficiency was found to have a "sparing effect" on iron status probably because the lower growth rate associated with riboflavin deficiency reduced iron requirements (Adelekan & Thurnham, 1986b). My studies also demonstrated that uptake of iron by immature red cells from riboflavin deficient rats was less than that of red cells from control animals and that total protein synthesis was also impaired in riboflavin deficient rats (Adelekan, 1989). The results of these studies were published in the *British Journal of Nutrition, Journal of Nutrition* based in the United States of America, and *Nutrition Research* based in Canada. The studies were well received by the global scientific community as the publications have been cited severally by other researchers.

Human Studies

As is often the case in science, research on riboflavin became less fashionable toward the end of the 1980s when global attention shifted to vitamin A. I promptly embraced the new fashion.

Vitamin A or retinol is found chiefly in foods of animal origin but can also be synthesised from its precursor, â-carotene found in abundance in coloured fruits and vegetables. Vitamin A plays a role in cell proliferation and differentiation and its precursor â-carotene has been reported to be protective against cancer and heart diseases. Childhood malnutrition is highly prevalent in Nigeria (Adelekan, 2001). We conducted vitamin A studies in children with severe oedematous malnutrition and showed that vitamin A status was poorer in these children than in well nourished controls, more because of the presence of underlying or current infections (Adelekan *et al.* 1991). We extended our studies to a group of free living preschool children in Nigeria. We showed that dietary vitamin A intake mostly from plant sources was adequate and the prevalence of vitamin A deficiency was low in these children but malnutrition was widespread. We showed significantly in our studies that childhood malnutrition of public health magnitude can coexist with adequate dietary vitamin A intakes or vitamin A status (Adelekan *et al.* 1997; Adelekan & Adeodu 1998). In collaboration with Professor Owa, of the Department of Paediatrics of this university, we reported a high prevalence of vitamin A deficiency in neonates especially amongst premature or low birth weight (<2.5 kg) babies which may have been a consequence of maternal malnutrition (Adelekan *et al* 2003). However, in an earlier study we could not demonstrate any correlation between the socioeconomic status of mothers and vitamin A status of neonates (Adelekan, Owa and Oyedeji, 2001).

Research work on malaria

My research work on malaria was supported by a generous research grant from the Nestle Foundation, Vevey, Switzerland. Malaria kills millions of children and adults annually. We studied the ability of plasma from malaria infected children to trap free radicals *in vitro* and we also measured the concentrations of secondary antioxidants (vitamins E and C) in the plasma. The results of our studies showed that the concentration of vitamins E and C were lower in plasma from malaria infected children than concentration in both control children and adult Caucasians. It was not

surprising therefore, to detect very low or absent radical trapping activity in plasma from malaria infected children by comparison with non infected children (Thurnham, Kootathep and Adelekan, 1988). We further showed that in areas where malaria and malnutrition coexist, malaria alone exerts greater influence in depressing plasma antioxidant vitamins A and E and â-carotene than malnutrition alone (Adelekan, Adeodu & Thurnham 1997). Using laboratory rats infected with rodent malaria parasite *P.berghei*, we showed that activity of the antioxidant enzyme, glutathione peroxidase (GPx) was higher in infected rats by comparison with uninfected controls. Since mature red cells lack the ability to synthesise new protein, we concluded that the higher GPx activities were probably due to parasite protein (Adelekan & Thurnham, 1998). Malaria infection also had no effect on superoxide dismutase (SOD) another antioxidant enzyme. This shows that primary antioxidant defence system was not compromised in malaria infection, in contrast to secondary antioxidant defence system represented by the antioxidant vitamins A, E and â-carotene whose concentrations in plasma are reduced in human malaria infection.

High dose vitamin A supplementation has been reported to reduce mortality in children (World Bank, 1993) and to be associated with a 30% reduction in *P. falciparum* febrile episodes compared to a placebo group (Shankar et al 1999). We studied the effect of red palm oil (a potent source of â-carotene) on the severity of malaria in Nigerian children aged < 60 months. Our results provided evidence that red palm oil consumption conferred a little protection against the severity of malaria but only in children aged > 36 months (Cooper, Adelekan, Esimai *et al.* 2002).

Sickle cell disease

Sickle cell disease is a prevalent genetic disease among black people. Sickled erythrocytes have been shown to be susceptible to lipid peroxidation and among the reasons suggested for this are disturbances in the oxidant defence mechanisms.

In collaboration with Professor Adekile formerly of the Department of Paediatrics of this university but now in the University of Kuwait, we carried out studies on antioxidant defences in 22 children aged 5-18 years with homozygous sickle cell disease and 9 HbA controls. We measured the plasma levels of vitamin E, vitamin A, carotenes and ascorbic acid. We also assessed the riboflavin status of the patients and controls. The results revealed that levels of all the antioxidants except ascorbic acid were reduced in SS patients by comparison with AA controls. Riboflavin status of the SS patients was also poorer than that of control children. We concluded that the reduced levels of antioxidants in the plasma of SS patients may render red cells more susceptible to oxidative damage and may be contributory to the haemolysis and vaso-occlusion that are characteristic of the disease (Adelekan, Thurnham & Adekile, 1989).

Table4 : Plasma antioxidant concentrations (ìmol/L) in SS patients and AA control subjects

	Control subjects			SS patients			Mann Whitney
Antioxidants	Median	min	Max	Median	Min	max	P<
á – carotene	2.43	0.40	3.29	1.55	0.52	2.23	0.05
â – carotene	3.24	0.50	5.08	2.20	0.71	3.68	n.s
Vitamin A	0.98	0.56	2.11	0.71	0.54	1.28	0.05
Ascorbic Acid	15.6	5.8	43.7	18.4	5.3	44.7	n.s
Vitamin E	18.02	3.40	47.60	11.32	5.56	16.90	0.02

Source: Adelekan, Thurnham & Adekile, 1989

Reports in the literature indicate that both riboflavin and pyridoxine metabolism are disturbed in sickle cell disease (Varma et al. 1983; Natta & Reynolds, 1984). We studied the relationship between riboflavin and pyridoxine metabolism in 40 children with sickle cell disease and 12 normal

children. Our results reported in the American Journal of *Clinical Nutrition* in 1987 showed that the prevalence of both riboflavin and pyridoxine deficiencies was lower in the patients than in the controls. Significantly in this study was our finding that pyridoxine status of patients but not of control children was directly affected by riboflavin status (Adelekan, Adekile & Thurnham, 1987).

Mother – child pairs

Studies examining nutrient intakes in parents and their children are scarce. We studied intakes of energy, protein, total fat and iron in 108 mother-child pairs. We found significant positive correlations between energy, total fat and iron intakes of mothers and their children but no significant correlation in protein intake of mothers and children. The results indicate an aggregation of nutrient intakes in mothers and their children which has important nutritional and health implications (Adelekan & Adeodu, 1997). It is well established for example, that risk factors for coronary heart disease such as obesity, high blood pressure and serum lipoproteins aggregate within families (Deutscher *et al.* 1966) and that diet influences these risk factors (Glueck & Commer, 1978) as I showed in the first part of this lecture.

Anaemia is a major public health problem in both developed and developing countries although the prevalence is much higher in developing countries. Anaemia is caused by a variety of factors including infections and worm infestation, but iron deficiency is recognised as the leading cause of nutritional anaemia in most people. In our study, we assessed the relative contributions of infections and iron deficiency to anaemia in Nigerian mothers and their children. We studied 61 mother-child pairs. Both mother and child were apparently well at the time of the study and neither had received blood transfusion in the 6 months preceding the study nor was any of the subjects on prophylactic or therapeutic iron or folate regimen. Our results showed that both infection and iron deficiencies were equally important aetiological factors in the anaemia recorded in the subjects of the study. (Adelekan & Adeodu, 1998).

Pregnant women

My research work on micronutrient status of pregnant women carried out in collaboration with colleagues in the Department of Obstetrics, Gynaecology and Perinatology and Department of Chemical Pathology of this university focused on 3 key micronutrients – zinc, copper and vitamin A.

We conducted studies to determine the changes in serum zinc and copper levels in 84 Nigerian women aged 16-42 years with uncomplicated pregnancy; 57 healthy non pregnant women matched for age served as controls. Our results showed that in normal pregnancy, a negative linear relationship exists between gestational age and serum zinc level i.e as pregnancy progresses, serum zinc level decreases. Serum copper does not show any significant trend throughout gestation, although concentration of copper in serum was higher in pregnant women than in non pregnant controls (Ajose *et al.* 2001).

Vitamin A deficiency is a major public health problem that requires prompt identification of high-risk populations for necessary intervention. Maternal vitamin A status has been found to have a strong impact on maternal performance during pregnancy and on the infant's vitamin A status (Codel et al. 1996). The need for adequate data on the vitamin A status of pregnant women in a population is strengthened by the finding that low dose vitamin A supplementation during pregnancy decreased maternal morbidity, mortality and the occurrence of xerophthalmia (West *et al.* 1994). We examined the relationship between vitamin A status, dietary habits and morbidity pattern in 200 pregnant women. We found that 55% of the pregnant women had borderline to deficient vitamin A status (serum retinol <0.7µmol/L). None of the presenting signs and symptoms except frequent micturition, had any significant influence on vitamin A status (Ajose, Adelekan & Ajewole, 2004). Our results further strengthened the claim that vitamin A deficiency is fairly prevalent in Nigerian pregnant women underlining the need for prompt and effective intervention.

Now to return to the topic of today's lecture: diet, nutrition and chronic diseases: what you eat is what you get. The situation on the island of St Helena illustrates beautifully the connection between diet, nutrition and the development of chronic diseases. In July of 2003, I had the opportunity to go on a 6 month mission for the World Health Organization (WHO) to the very tiny island of St Helena in the South Atlantic Ocean with a population of less than 4000. My assignment on the Island was twofold. The first was broadly to raise awareness of nutrition issues on the island. The second was to conduct a nutrition baseline survey. It was quite obvious to me on arrival on the island that a good number of people are overweight or obese. Results of nutritional status assessment revealed that 36.6% of adults on the island were overweight while 32.8% were obese with 1.5% morbidly obese (BMI >40.0kg/m^2) indicating that about 70% of adults on the island were either over weight. When data were disaggregated by sex, more females (36.7%) than males (28.4%) were found to be obese while a slightly higher percentage of males (37.8%) than females (35.5%) was overweight. In school age children, we found that over 20% were overweight while 8% were obese. In contrast to the adults, more boys (11.4%) were found to be obese than girls (4.1%). The results of the baseline nutrition survey revealed that consumption of starchy foods was high with bread being the main source of carbohydrate in the diet of St Helenians. Nine out of 10 households consumed bread every day of the week with an average of 3kg per week. Consumption of sweets and processed foods high in fat and salt is prevalent on the island just as fast foods.

Elderly inhabitants of the island confirmed to me that the current dietary habits and life styles on the island differed significantly from those of 50 years ago. The consequence of these changes is that in 2004, there were1000 hypertensive and 450 diabetic patients on the island out of a population of less than 4000 with many other patients receiving treatment for raised blood cholesterol and heart diseases. One common underlying factor in all these diseases is that obesity is a risk factor but the islanders did not associate the high prevalence of these chronic non communicable diseases with obesity.

Table 5: Frequency of consumption of starchy foods by ouseholds on the island of St Helena

Food item	Number of times consumed/week				
	1 – 3	4 – 6	Daily	Occasionally	Never
	% of households				
Bread	5.3	4.9	88.0	1.5	0.1
Potato	20.1	19.0	57.4	2.7	0.8
Rice	25.7	27.1	37.0	7.9	2.3
Pasta	40.6	1.2	0.8	33.7	23.5

However, consumption of fruits and vegetables was rather low. Regular consumption of fruits is very low on the Island. Less than 20% of the households surveyed consumed fruits on a daily basis. The vast majority (75%) of households consumed fruits occasionally, because fruits are imported from South Africa and therefore relatively expensive. Even when fruit is consumed, the portion consumed is low. For example, more than half of the households surveyed consumed one portion of fruits per week, one third consumed two portions of fruits per week and a little over 10% of the households consumed three to four portions of fruits per week.

Consumption of vegetable is much higher than for fruits. This is probably due to the fact that some vegetables are grown locally on the Island. Over half of the households surveyed consumed vegetables on a daily basis while 20% consumed vegetables occasionally. The average household consumed two portions of vegetables per day.

In general fruit and vegetable consumption on the Island is below the recommended five portions of fruits and vegetables per day.

Table 6: Frequency of consumption of fruits and vegetables by households on the island of St Helena

Food item	Number of times consumed/week				
	1 – 3	4 – 6	Daily	Occasionally	Never
	% of households				
Fruits	3.3	1.0	17.0	75.8	2.2
Vegetables	12.4	7.5	58.0	22.1	-

The case of this tiny island is typical of the health consequences experienced by countries adopting western type diets. Sadly, Nigeria and Nigerians are going the same way.

Conclusion

To conclude this lecture, I wish to re-emphasise the importance of prudence in our dietary habits. Nature has endowed us in this part of the world with all the right kinds of food to maintain good health. We must utilise these food items judiciously. All that comes from the West is not always good for us. We should take what is good and discard what is bad in the Western diet. The West today is spending billions of dollars annually to reverse the harm done by faulty eating habits and losing billions more as a result of premature deaths from chronic diseases. In 2005 alone, WHO projected that Nigeria lost about US$400 million in national income from premature deaths due to heart disease, stroke and diabetes. These losses are projected to continue to increase such that cumulatively by the year 2015, WHO projects that Nigeria will lose about 8 billion dollars from premature deaths due to heart disease, stroke and diabetes. We cannot afford these huge losses. What is required in my professional judgment to reverse the trend is a change of lifestyle including adoption of healthy eating habits, regular physical exercise, reduction in or cessation of smoking and alcohol use. Multi sectoral approach is required to tackle the problem of diet related chronic non communicable diseases in this country to involve the Ministries of Health, Education, Information, Sports, Agriculture and Technology. WHO projects that if Nigeria is able to sustain an annual 2% reduction in

national level chronic disease death rates over a 10 year period, this will result in economic gain of 500 billion dollars for the country.

Finally Mr Vice-Chancellor Sir, it is my considered opinion that our great university, the Obafemi Awolowo University, Ile-Ife, is over due to have a full fledged, stand alone Department of Nutrition. Today in this university, nutrition is taught in various departments and faculties. In the College of Health Sciences alone, nutrition is taught in the Faculty of Dentistry, and in the Departments of Community Health, Nursing, Medicine, Paediatrics, Obstetrics and Gynaecology, and Surgery. Elsewhere in this university, nutrition is taught in the Faculties of Education, Science, Agriculture and even in the Faculty of Technology. Mr Vice-Chancellor Sir, I do not know of any other course that cuts across so many departments and faculties as nutrition. Nutrition has been recognised as a distinct discipline from Biochemistry and Physiology since 1951 and several universities around the world now offer undergraduate and post graduate degree programmes in Nutrition. Here in Nigeria, several universities today have Departments of Nutrition. Nutrition as a discipline is lucrative, offering employment opportunities in academics, health, agriculture, the food industry, hospitality industry and international organisations. Nutrition is vital for national development. I humbly submit Sir, that Nutrition deserves a separate department of its own in this university.

I thank Almighty Allah for His mercies on me and my family. I acknowledge with thanks financial support for my research work from both local and international donors notable amongst which are the University Research Committee of this university, Nestle Foundation of Switzerland, The British Council, The Royal Society UK, The World Bank, WHO and UNICEF. I thank friends and relations who have come from far places to honour me with their presence today. I thank all my colleagues and co-researches for their contributions to my research efforts over the years. Finally, I thank my wife and children for their support and encouragement which have helped to bring me this far.

In ending this lecture, Mr Vice-Chancellor, distinguished guests, ladies and gentlemen, I sincerely hope that in the matter of diet, nutrition and chronic diseases, I have shown that indeed what you eat is what you get. I thank you all for listening.

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