NUTRIGENOMICS A NEGLECTED CORNERSTONE IN NATIONAL DEVELOPMENT

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UNIVERSITY OF IBADAN

NUTRIGENOMICS: A NEGLECTED CORNERSTONE IN NATIONAL DEVELOPMENT

An inaugural lecture delivered at the University of Ibadan

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By

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The Vice-Chancellor, Deputy Vice-Chancellor (Administration), Deputy Vice-Chancellor (Academic), Registrar, Librarian, Provost of the College of Medicine, Dean of the Faculty of Public Health, Dean of the Postgraduate School, Deans of other Faculties and of Students, Directors of Institutes, Distinguished Ladies and Gentlemen.

Preamble

I consider it an honour to be invited to deliver this year's inaugural lecture on behalf of the Faculty of Public Health. It is the 5th inaugural lecture coming from the Faculty since its inception some nine years ago. Coincidentally, it is also the fifth from the Department of Human Nutrition since its establishment as a unit and its eventual evolution to a department. I have had the opportunity to deliver keynote addresses at various national and international fora including a 1990 convocation lecture at the Lagos State University (LASU). However, being given an opportunity to deliver an inaugural lecture in the premier University, the University of Ibadan, the first and the best, is the ultimate in one's academic achievement.

Mr. Vice-Chancellor Sir, my foray into the field of Nutrition was quite fortuitous as I was originally given admission to study Biochemistry in the Faculty of Science at the University of Ibadan in the 1966/67 session. However, before the end of my first year, the Faculty of Agriculture advertised a new degree programme in Biochemistry and Nutrition under the late Professor (Emeritus) Victor Oyenuga. I got an appointment to see him in order to find out more about the course and the advantage of having a degree in Biochemistry and Nutrition instead of just Biochemistry. At the end of the session, I decided to switch to the new programme because I saw it as killing two birds with one stone by having one degree in two disciplines. Having settled down in this new department, I began to develop a very strong interest in nutrition through my contact with the Editor of the American-based Journal of Nutrition, Professor Richard Barnes, who was the Dean of the Graduate School of Nutrition at Cornell

University in Ithaca, New York. Incidentally, Professor Oyenuga had spent his sabbatical year at Cornell during the 1960/61 session and two of my teachers, Professors G M Babatunde and B K Ogunmodede were also products of Cornell University. Both of them supported my desire to study at Cornell. Indeed, they served as my referees in my application to the Graduate School of Nutrition. At my interview at Cornell, I was asked which textbook we used for the course in Biochemistry and I proudly told them that it was *Biochemistry* by West and Todd. I was immediately advised to go to the Cornell bookshop to obtain the new Biochemistry textbook by Lehninger! Obviously, they thought my Nigerian degree was a bit inadequate so I had to start with a 400 Level course in Biochemistry. Professor Richard Barnes was my supervisor throughout my stay at Cornell, assisted by Professor Wilson Pond. Professor Pond had previously supervised Professor Babatunde who was my own teacher at Ibadan.

My engagement at the University of Ibadan on the completion of my training at Cornell was also fortuitous. When our final year results were released at the University of Ibadan, the late Mr S. A. O. Odumuye who was in charge of student affairs at that time got me an appointment to meet the then Director of the Food Science and Applied Nutrition Unit, Professor Adewale Omololu, to explore the possibility of being engaged as a Junior Research Fellow of the Unit in 1970. However, there was no vacant position available. Two years later, in 1972, Professor Omololu visited Cornell as a guest of the Graduate School of Nutrition and, as the only Nigerian student in the school, I was his 'chaperon.' I arranged a reception for him in our flat. We discussed my programme at Cornell and Professor Omololu was so pleased at the depth and pace of my research that he requested me to get in touch with him as soon as I finished my training, with the prospect of employment as a Lecturer in the Unit. Thus, my plan to return to Ibadan began to take shape three years before I completed my PhD programme!

From Cornell to Ibadan

I returned to Ibadan from Cornell University in September 1975 after the completion of a PhD degree programme in Nutrition armed with a letter of appointment as Temporary Lecturer II. During those early days, Nigeria was a virgin land as far as nutrition research was concerned. There was no data on the nutritional status of the population and planning for all national developmental activities was conducted without any consideration for the nutrition situation in the country! I must say at this juncture that any national planning agenda which does not take into cognizance the nutrition situation in the country may be an effort in futility as we shall realize in the course of this lecture.

When I joined the staff of the University of Ibadan in 1975, my department was known as the Food Science and Applied Nutrition Unit (FSANU). I networked with other members of staff to prepare a proposal for the upgrading of the Unit to a full department. I was invited to a meeting of the University Development Committee where I presented the proposal and the Unit was given full departmental status during the 1976/77 session.

My appointment into the Unit presented a great challenge because I discovered that there was no standard curriculum to train the set of students on ground. I was very much concerned about the curriculum that was being run by the Unit, based on my experience as a Teaching and Research Assistant at Cornell. The need to update the nutrition curriculum at the time to meet international standards was the first task I had to tackle. I was given the opportunity, working with other members of staff, to review and expand the curriculum. My desire as a fresh, young lecturer at that time was to introduce some of the courses offered at Cornell. The curriculum, updated at that time, still forms the template for the present B.Sc. and M.Sc. degree programmes.

Brief History of the Department of Human Nutrition

The present Department of Human Nutrition started in 1963 as the School of Food Science and Applied Nutrition Unit,

which jointly offered a Certificate Course with the Nutrition Unit of the London School of Hygiene and Tropical Medicine. The foundation members included J.C Edozien (the present Asagba of Asaba), A.O. Omololu, I.S. Dema, Mrs. E.O. Olusanya, Mrs. B.O. Osifo, A.O. Ketiku and E. Banigo. The School spear-headed the planning and execution of the very first country-wide nutrition survey conducted in 1965. The political crisis of 1967-70 destabilized its activities with many members of staff being forced to leave. This action transformed the School into an Inter-Faculty Serving Unit. The first Certificate course solely conducted by the Unit was in 1968. Within 10 years of its existence (1963-73), a total of 221 students were trained, including 142 from other African countries. The course was intended to provide a pool of nutrition experts for Nigeria and other developing countries all over the world.

The School of Food Science and Applied Nutrition Unit took off from the present ARCIS building (right behind the present Departmental building). However, in 1970, the Unit benefited from a Rockefeller grant to the University to raise a building for the staff and students. The building houses a library which is currently being used as a classroom/seminar room, two laboratories – one for staff and the other for Postgraduate students, two small stores for chemicals and stationery as well as offices for the staff.

The 1971/72 session saw the introduction of a 10-month Diploma course in Nutrition for graduates aimed at producing middle grade and high level nutrition professionals. The Unit was transformed into a fully-fledged degree-awarding Department in the 1976/77 session, barely a year after the proposal was presented to the Senate through the Development Committee. The B.Sc programme commenced with an intake of five students who graduated in 1982. Also, in 1979, the 10-month Postgraduate Diploma course was upgraded into the Master's degree programme in Human Nutrition, with an initial intake of 3 students. The admission into the Ph.D.

programme in Human Nutrition was jointly supervised by the Departments of Human Nutrition and Chemical Pathology.

Nutrigenomics

Mr. Vice-Chancellor Sir, all diseases have a genetic predisposition (Simopoulos 2010). The interaction of genetics and environment, nature and nurture, is the foundation for all health and disease (Simopoulos 2004). Genes define susceptibility to a disease or condition, and environmental factors such as diet and exercise determine who among the susceptible will develop the disease or condition (Simopoulos and Childs 2004) (fig. 1). Nutrition is an environmental factor of major importance. Methodological advances in molecular biology and genetics have facilitated the study of inherited diseases at the DNA level and of nutrients at the molecular level. This research has led to (*a*) the development of concepts and research on genetic variation and dietary response, known as nutrigenetics (e.g., individuals responding differently to the same diet by attaining different levels of serum cholesterol and blood pressure because of genetic variation), and (*b*) studies on the evolutionary aspects of diet and the role of nutrients in gene expression, known as nutrigenomics [e.g., polyunsaturated fatty acids (PUFA) suppress fatty acid synthase (mRNA) gene expression]. The term nutrigenetics was introduced by Brennan in 1975 in *Nutrigenetics: New Concepts for Relieving Hypoglycaemia.*

Nutrigenetics/nutrigenomics could provide a framework for the development of genotype dependent novel foods for health promotion and for the prevention and management of chronic diseases. National general dietary guidelines have been issued for the prevention of chronic diseases without considering the effects of genetic variation on dietary responses, despite such evidence (Zeisel 2008).

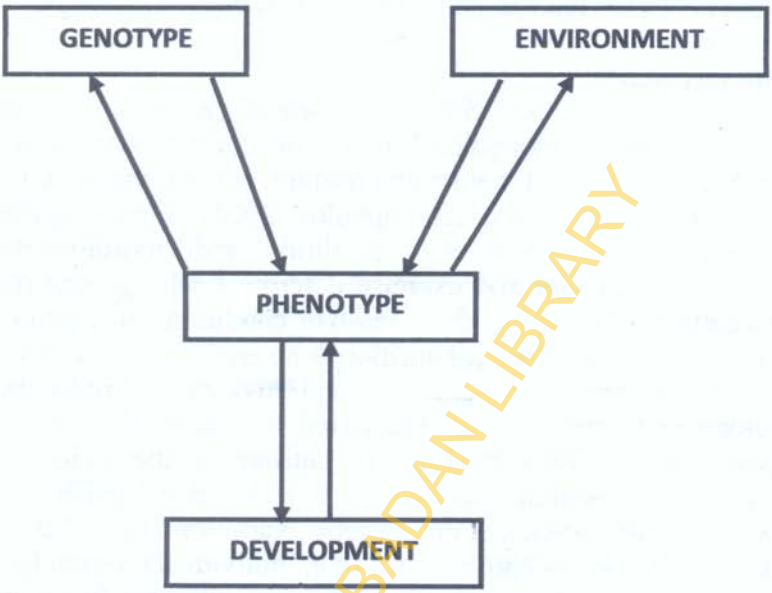

Fig. 1: Relationship between genes, environment and development are dynamic (Adapted from Simopoulos and Chilts (1990))

Nutrigenomics, sometimes termed nutritional genomics, describes the biological and statistical interaction among dietary chemicals and the genetic make-up. These interactions vary because individuals have unique combinations of common gene variants that are differentially affected by diet. The relationship between diet and genes impacts the effects of diet on disease risk susceptibility, nutrient requirement, and even treatment modalities. This new genetic nutrition approach describes nutrients in one of their biological roles, that is, as 'signalling molecules' that are recognized by cellular sensing mechanisms and result in the translation of these dietary signals into changes in gene, protein, and metabolite expressions. At the genomic level, these molecular changes serve as dietary 'signatures' or 'fingerprints' that can precisely annotate the phenotype, particularly under conditions of

metabolic stress and early phases of organ-specific changes e.g. insulin resistance.

Nutrigenomic Goals and Outcomes

The goals and expected outcomes of nutrigenomics are:

1. Prevent or delay onset of disease and optimize or maintain human health;
2. Identify individuals who are responders and can benefit from specific dietary interventions;
3. Develop evidence-based healthful food and lifestyle advice and dietary interventions;
4. Identify how human genetic variation affects nutritional requirements; and
5. expand understanding of the genetic mechanisms underlying health, the basis of individual variation, and conditions when diet influences metabolism.

The goal of 'individualizing' or 'personalizing' nutrition for a single unique individual may or may not be achievable but as the nutrigenomics field progresses, areas of commercialization are emerging, such as companies offering diets designed for individuals based on genetic analyses of between one and about thirty gene variants. More than 500 tests of genetic variations exist.

Nutrigenomics as the Neglected Cornerstone of National Developmental Agenda

Mr. Vice-Chancellor Sir, having presented information on the concept of Nutrigenomics, it is important to re-instate the relevance of general nutrition to national development agenda. It has long been known that malnutrition undermines economic growth and perpetuates poverty in so many ways. Yet, most governments in developing countries have failed to tackle malnutrition over past decades, though well-tested approaches for doing so exist. The consequences of this failure to act are now evident in the inadequate progress made towards the Millennium Development Goals (MDGs) and

towards poverty reduction in general. Persistent malnutrition is contributing not only to widespread failure to meet the first MDG (to halve poverty and hunger), but also to failure in meeting other goals in maternal and child health, HIV/AIDS, education and gender equity. The unequivocal choice now is between continuing to fail or to finally make nutrition central to development so that a wide range of economic and social improvements that depend on nutrition can be realized.

Malnutrition slows economic growth and perpetuates poverty through three routes—direct losses in productivity from poor physical status (ill-health), indirect losses from poor cognitive function and deficits in schooling (poor academic performance), and losses owing to increased healthcare costs. Malnutrition's economic costs are substantial: productivity losses to individuals are estimated at more than 10 percent of lifetime earnings, and gross domestic product (GDP) lost to malnutrition runs as high as 2 to 3 percent. Improving nutrition is therefore as much, or more, of an issue of economics as one of welfare, social protection, and human rights. Reducing under-nutrition and micro-nutrient deficiencies directly reduces poverty, in the broad definition that includes human development and human capital formation. Under-nutrition is also strongly linked with income poverty and this means that improving nutrition is an anti-poverty strategy which increases the income-earning potential of the poor (The World Bank 2006).

Milestones in Research

My first series of academic papers were published in the 70s while at Cornell. These papers emanated from both my Master's and doctoral research work on the effect of protein energy malnutrition on the changes in the plasma levels of growth hormone, thyroxine, adreno-corticosteroids and insulin (Atinmo et al.1974, 1976, 1978). When I resumed at Ibadan, there were no laboratory facilities to continue this kind of study. I became interested in nutrition in pregnancy and infant nutrition, especially in the area of the trace elements zinc, iron and copper—now referred to as 'micro-

nutrients'. This had not received adequate attention at the time. I commenced my research pursuits, focusing on two categories of target groups—women and children. My first published work was on zinc and this was in conjunction with one of my students, Carl Mbofung, a Cameroonian, and now a Professor of Nutrition of international repute. Inadequate intake of zinc was discovered among different age groups in selected Nigerian villages (Mbofung and Atinmo 1980). Average daily intake was generally low but it increased with age. Food sources of zinc were mostly of plant origin and assuming a 20% availability of zinc from the diet, the intake by lactating women was a little over 20% of their daily requirement (table 1).

Table 1: Dietary Zinc Intake as Percentage of Requirement

Age (Years)	Zinc Intake (mg/day)	Percentage of Requirement
1 – 10	3.61	45.0
11 – 17	3.94	30.0
18+	7.30	66.0
Pregnant Women	6.02	40.0
Lactating Women	6.09	22.0

In another study (table 2), a direct relationship was also observed between maternal zinc and copper status and infant birth weight (Atinmo, Mbofung and Osinusi 1980). Maternal and cord blood zinc levels were lower in the low birth weight group (<2500g) while plasma copper was significantly higher than in the control group (>2500g). There were significant correlations between birth weight and the concentrations of zinc and copper in both maternal and cord blood which suggests these elements play a significant role in the incidence of low birth weight in Nigeria. This would have very serious implications in this environment where the diets are mostly cereal based with very little contribution from animal sources.

Table 2: Zinc & Copper Concentrations in Maternal & Cord Blood by Infant Birth Weight

		CASES (< 500g)	CONTROL (> 2500g)
ZINC			
	MATERNAL BLOOD	66.31	73.15
	CORD BLOOD	83.37	89.52
	RATIO	0.82	0.80
COPPER			
	MATERNAL BLOOD	221.86	203.59
	CORD BLOOD	60.29	56.48
	RATIO	4.59	4.04

We followed this with a study of the plasma zinc status of protein energy malnourished children in Nigeria (Atinmo, Johnson, Mbofung and Tindimebwa 1982). Plasma zinc levels were low in the malnourished group and this tended to vary with the degree of malnutrition (whether severe or moderate). Zinc levels in the 'normal' children suggest the presence of a marginal zinc nutrition among Nigerian children (table 3). Plasma zinc concentration tended to decrease with increasing severity of growth retardation (Atinmo, Umezurike and Laditan 1985).

Table 3: Plasma Zinc, Albumin and Alkaline Phosphatase of Different Groups of Malnourished Children (mean ± S.D)

	CONTROL (10)	MARASMUS (10)	MARASMIC KWASHIORKOR (11)	KWASHIORKOR (13)	UNDERNUTRITION (10)	F*	P valve
Plasma zinc(µg/dl)	73.15 ± 12.9	46.7 ± 12.2[a]	40.18 ± 19.5[a]	41.61 ± 9.1[a]	47.9 ± 16.80[a]	7.35	.05
Albumin (g/dl)	3.11 ± 0.31	2.41 ± 0.50[b]	2.50 ± 0.60[b]	2.29 ± 0.44[b]	2.66 ± 0.45[b]	8.81	.05
Alkaline Phosphatase (iu/l)	145.14 ± 28.65	89.65 ± 8.51[c]	87.59 ± 14.64[c]	85.52 ± 8.70[c]	104.65±30.26[c]	19.4	.01

Number in parenthesis shows number of samples analysed in duplicate.
[a, b, c] = values not significantly different from each other.
*F = One way analysis of variance.

Again, in 1982, Atinmo and Omololu determined trace elements contents of breast milk from mothers of pre-term infants in Nigeria (table 4). We found that even at low trace element intake, there were higher levels in the breastmilk of mothers of pre-term babies when compared to mothers of term babies. These high levels are probably needed to meet the growing needs of the pre-term infants. However, the fall in trace element content of breastmilk during lactation was more dramatic in mothers of pre-term infants.

In 1983, Atinmo, Ogun and Akinkugbe monitored the plasma levels of transport proteins (retinol-binding proteins, cerulo-plasmin and transferrin) during the rehabilitation of thirty protein-energy malnourished children aged 6-54 months (table 5). At the end of the 12-week rehabilitation period, there was no significant difference in the plasma transport protein levels between the previously malnourished children and the normal controls although the malnourished children still demonstrated significant weight deficit. The results showed that the rehabilitation in terms of the diet supplementation of the children through nutrition education of the mothers, resulting in an improved protein and calorie intake, contributed significantly to the linear rise in plasma levels of the transport proteins while the growth retardation remained an adaptation to the previous protein energy status of the malnourished children (table 6).

Table 4: Mean Copper, Zinc and Iron Contents of Colostral, Transitional and Mature Milk from Mothers of Pre-Term and Term Infants

MILK	COPPER (µg/ml)		ZINC (µg/ml)		IRON (µg/ml)	
	Pre-term	**Term**	**Pre-term**	**Term**	**Pre-term**	**Term**
Colostrum	0.54 ± 0.25^{a}	0.34 ± 0.13	7.14 ± 1.42^{a}	5.98 ± 1.12	1.05 ± 0.28^{b}	0.56 ± 0.27
Transitional	0.33 ± 0.06	0.31 ± 0.19	5.91 ± 0.72	5.49 ± 0.73	0.84 ± 0.16	0.49 ± 0.20
Mature	0.30 ± 0.15^{a}	0.27 ± 0.02	5.36 ± 1.60^{b}	3.93 ± 0.78	0.78 ± 0.30^{a}	0.43 ± 0.16

Values are the mean $\pm$ S.D. There were 20 subjects from term group & 15 from the pre-term group.

[a] – **Significantly higher than the term group at $P < 0.01$.**

[b] - **Significantly higher than the term group at $P < 0.05$.**

Table 5: Mean Values of Plasma Transport Proteins of Normal Children (N = 10) and Rehabilitated Malnourished Children (N = 30)

Transport Protein*	Week 0		Week 4		Week 8		Week 12	
	Normal	**Malnourished**	**Normal**	**Malnourished**	**Normal**	**Malnourished**	**Normal**	**Malnourished**
Prealbumin								
Mean	13.56	7.35	14.53	13.0	16.70	14.11	16.90	14.54
SD	2.71	3.43	3.70	2.86	2.83	3.83	2.72	2.81
Retinol binding Protein								
Mean	3.40	1.38	3.80	2.70	4.24	3.28	4.42	3.82
SD	1.01	1.10	0.81	0.92	0.76	0.88	0.91	0.84
Transferrin								
Mean	398.94	162.43	410.24	296.84	443.67	339.80	464.72	387.24
SD	72.23	56.85	66.78	88.45	57.16	87.35	84.56	90.37
Cerulo-plasmin								
Mean	32.40	19.44	37.36	26.63	44.98	40.07	47.34	46.50
SD	9.33	8.27	8.79	6.03	6.12	7.42	9.75	6.25

SD = Standard Deviation.
*** In µg/dl**

Table 6: Mean Values of Anthropometric Measurements of Normal Children (N = 10) and the Rehabilitated Malnourished Children (N = 30)

Parameter	Week 0		Week 4		Week 8		Week 12	
	Normal	Malnourished	Normal	Malnourished	Normal	Malnourished	Normal	Malnourished
Weight(%)*								
Mean	96.84	59.41	96.64	61.97	96.94	70.08	97.54	74.77
SD	8.26	17.04	4.46	12.80	4.84	8.16	4.24	5.54
Height(%)*								
Mean	95.62	85.77	95.94	88.83	96.08	87.28	96.42	89.45
SD	3.58	5.05	3.24	2.92	3.48	2.05	2.88	3.15
Mid-arm Circumference (cm)								
Mean	12.71	9.46	12.80	9.68	12.91	10.18	12.90	10.48
SD	1.16	0.85	1.08	0.76	1.04	0.81	0.92	0.62

SD – Standard Deviation.
*** - Percentage of the local standard**

Zinc and phytate concentrations and metallocalorie ratio of zinc and protein contents of some selected Nigerian dietary foods were established (Mbofung, Atinmo and Omololu 1984). The results of this study showed that most of the plant-based foods which are commonly consumed in Nigeria have low concentrations of zinc which are closely related to their protein and phytate contents. Food based on cereals has relatively higher zinc concentrations as shown by their metallocalorie ratio, but it appears that zinc will be less available from cereals and legume based foods than from roots or vegetables (table 7).

Table 7: Zinc, Phytate, Protein Content, Phytate: Zinc Molar Ratio (PZMR) and Metallocalorie Ratio of Zinc (MCR-Zn) in Dietary Foods Analysed

Food Item	Zinc (ppm)		Protein (g/100g)		Phytate (mg/100g)		PZMR	MCR-Zn (mg/10^3Kcals)
	Mean	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**		
Amala Lafun (C)	10.5	1.6	3.6		189	12.0	18:1	2.9
Amala Isu (Y)	19.3	4.3	4.1		167	5.0	8:1	4.6
Garri (C)	9.8	2.0	1.4		33	0.8	3:1	2.0
Eba (C)	10.8	1.9	1.3	0.4	47	6.0	4:1	2.5
Pounded Yam (Y)	16.2	1.9	6.1	0.5	130	10.0	8:1	2.6
Asaro (Y)	22.0	3.2	6.6	2.8	134	15.0	6:1	3.0
Mashed Beans (B)	27.4	3.8	22.7	3.2	413	59.0	15:1	6.6
Moin-Moin (B)	28.0	3.2	19.9	1.0	295	60.0	10:1	4.0
Alapa (B)	27.9	2.5	32.6	6.2	582	110.0	21:1	5.5
Akara (B)	24.1	2.4	18.1	1.7	248	28.0	10:1	4.2
Eko Tutu (M)	23.0	2.7	9.4	0.5	475	122.0	22:1	5.8
Ogi (M)	19.0	1.8	9.8	0.3	456	110.0	24:1	4.2
Adun (M)	19.7	3.1	8.9	0.4	461	81.0	23:1	4.0
Adalu (M+B)	22.0	2.6	14.1	0.7	500	127.0	22:1	2.3
Bread (W)	13.1	2.7	9.6	0.5	206	70.0	15:1	3.8
White Rice	9.0	2.2	8.0	0.4	52	11.0	6:1	2.2
Pepper Sauce	8.8	3.9	3.3	0.3	35	18.6	4:1	1.1
Okro + Melon Soup (Me)	25.7	5.1	10.2	1.8	118	14.9	5:1	3.7
Ewedu Soup (V)	5.2	2.3	3.3	0.5	30	9.0	6:1	1.3
Bitter Leaf Soup (V)	10.9	1.8	6.7	1.2	179	12.0	16:1	0.7
Ewedu + Melon Soup (Me)	26.6	3.2	9.9	1.6	150	18.0	7:1	3.9

Figures in parenthesis indicate the major food component in the food items:
C = **Cassava** – ***Manihot utilissima.*** B = **Beans** – **Cowpea** – ***Vigna Sp.*** Me = **Melon Seeds** – ***Cucumeropsis Sp.***
Y = **Yam** – ***Dioscorea ayennensis.*** V = **Vegetables** – **e.g. bitterleaf** – ***Vero nia amygdeatina.*** M = **Maize** – ***Zea-Mays***

Influence of maternal age, parity and haemoglobin status on plasma zinc, copper and iron concentrations in pregnant and lactating Nigerian women was assessed by Mbofung and Atinmo in 1985. Information from this study revealed that plasma copper levels in pregnancy are higher and are influen-ced not only by the length of gestation but also by maternal age and parity as well as by maternal haemoglobin status (table 8). The study confirmed the negative influence of early marriage and multi-parity on maternal nutrition (table 9).

Table 8: Effect of Length of Gestation and Parity on Plasma Copper Levels

		Length of Gestation (Weeks)				
		<31	**31 – 34**	**>34**	**F**	**P**
PARITY	**2**	180.9 ±23.2 (41)	207.3 ±25.8 (61)	219.9 ±20.3 (51)		
	2-3	191.9 ±22.1 (67)	215.1 ±23.1 (73)	224.1 ±23.7 (100)	73.95	.00001
		193.1 ±28.7 (31)	216.3 ±19.6 (34)	219.7 ±20.7 (42)		
	F		5.35		F* = 0.83	
	P		0.005		P = 0.51	

Figures in parenthesis represent sample sizes. F is obtained from one way analysis of covariance, while F* is obtained from two way analysis of variance. P = level of significance.

Table 9: Maternal Age (Years)

		<21	21 – 29	>29	F	P
Length of Gestation (Weeks)	**<31**	184.7	190.5	188.2		
		±21.8	±24.5	±25.9		
		(22)	(75)	(42)		
	31-34	200.9	215.6	217.9	5.96	
		±21.8	±24.1	±20.8		
		(42)	(87)	(39)		
	>34	217.2	225.6	217.8		
		±20.8	±22.4	±20.9		
		(34)	(109)	(50)		
	F		64.6		F* = 1.7	
	P		0.0001		P = 0.05	

Figures in parentheses represent number of subjects in group. F values are obtained from one way analysis of variance; F* values are obtained from two way analysis of variance. P = level of significance.

The micro-nutrient content of breast milk from Nigerian lactating women was assessed to provide national data on the quality of milk produced to feed the babies (Atinmo and Omololu 1982). There was evidence that up to the third month post partum, the plasma levels of zinc and iron in lactating Nigerian women (entirely breastfeeding their babies), are relatively lower than those of non-pregnant, non-lactating controls while the plasma copper level is higher in these lactating women compared to the controls (table 10).

Table 10: Effect of stage of lactation on concentrations of plasma trace elements and albumin in lactating Nigerian women (Mean Values and Standard Deviations)

Stage of Lactation (weeks)	N	Zinc (µg/l)		Copper (µg/l)		Iron (µg/l)		Albumin (g/l)	
		Mean	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**
4	67	650.0	61.0	1370.0	160.0	660.0	190.0	31.0	3.0
8	76	658.0	76.0	1310.0	150.0	768.0	170.0	34.0	4.0
12	89	684.0	83.0	1230.0	120.0	750.0	180.0	33.0	4.0
One-way analysis of variance: *F*		4.37**		16.90***		4.19*		6.9**	
Correlation coefficient: *r*		0.19*		-0.36***		0.15*		0.13*	

* - P < 0.05, ** - P < 0.01, *** - P < 0.001

Adeniran and Atinmo in 1986 also investigated serum calcium and zinc levels of teenage mothers and their newborn babies, with findings suggesting very low statuses. This study illustrated the patterns of calcium and zinc status in the Nigerian pregnant teenage girls and their babies as well as adult mothers. It also showed that while both groups of mothers transferred safe levels, the adult women still maintained low levels while the teenage mothers had much lower levels due to increased physiological needs (table 11).

Table 11 : Calcium, Zinc and Albumin Status in the Mothers and Babies

Nutrients	Adult Group			Teenage Group			Babies		
	AM n=26	**ANP n=24**	**Statistical significance (t - test)**	**TM n=11**	**TNP n=22**	**Statistical significance (t - test)**	**BAM n=26**	**BTM n=11**	**Statistical significance (t-test)**
Calcium(mg/dl)									
Range	3.2-14.69	3.86-14.39		5.95-11.95	4.63-14.78		4.39-19.02	9.10-16.27	
Mean ± S.D	9.18 ± 2.5	10.26 ± 3.73	P > 0.05	9.33 ± 1.59	11.11 ± 2.16	P < 0.05	11.24 ± 3.43	12.88 ± 2.36	P < 0.05
Zinc (µg/dl)									
Range	20.34-81.36	40.68-11.86		30.15-50.81	24.39-87.46		25.42-125.08	36.61-113.79	
Mean ± S.D	48.05± 15.99	71.93± 21.08	P < 0.05	39.18± 9.33	54.45± 20.63	P < 0.05	64.06± 24.59	63.01± 23.34	P > 0.05
Albumin(mg/dl)									
Range	2.03 – 6.65	2.25 – 6.90		2.02 – 5.93	1.70 – 6.85		3.09 – 6.83	2.82 – 6.24	
Mean ± S.D	4.51 ± 1.31	4.19 ± 1.27	P > 0.05	3.57 ± 1.40	4.06 ± 1.38	P > 0.05	4.55 ± 1.09	4.23 ± 1.14	P > 0.05

A study on the effect of oral zinc supplementation on plasma and urinary zinc, calcium and magnesium of young adult Nigerians was conducted by Atinmo et al. (1986). Plasma and urinary zinc, calcium and magnesium increased during the 6-weeks of oral zinc supplementation with a significant fall in urinary zinc and calcium levels post supplementation (table 12). Urinary magnesium actually fell during the supple-mentation period table 13). Thus oral zinc supplementation has a significant effect on zinc and calcium balances, and on magnesium balance to a lesser effect.

Table 12: Mean Plasma Calcium, Magnesium & Zinc levels during the 3 phases of the study (range in parenthesis)

	Before supplementation	During supplementation	After supplementation
Calcium (mg %)	8.49 ± 0.75 (7.3 – 9.3)	14.37 ± 2.32 (10.4 – 18.4)	11.41 ± 1.26 (9.1 – 14.0)
Magnesium (mg %)	1.77 ± 0.67 (0.94 -3.41)	2.17 ± 0.4 (1.57 – 3.0)	1.78 ± 0.44 (1.03 – 2.39)
Zinc (mg %)	76.5 ± 16.93 (55 – 116)	131.3 ± 35.77 (87 – 192)	86.2 ± 22.71 (65 – 139)

Table 13: Mean Urinary Calcium, Magnesium & Zinc levels during the 3 phases of the study (range in parenthesis)

	Before supplementation	During supplementation	After supplementation
Calcium (mg/day)	160.93 ± 68.1 (92.2 – 295.8)	458.5 ± 218.3 (100.8 – 041.7)	256.12 ± 92.69 (145.1 – 462.2)
Magnesium (mg/day)	70.0 ± 21.1 (40.0 – 105.0)	65.54 ± 23.2 (20.0 – 99.0)	60.7 ± 15.7 (42.0 – 93.0)
Zinc (µg/day)	223.5 ± 129.54 (112.0 – 602.0)	599.9 ± 247.76 (192.0 – 937.0)	299.5 ± 138.21 (153.0 – 534.0)

All these studies were conducted to determine the extent of nutritional problems in the country as they would provide the baseline information to conduct appropriate intervention. Some of these findings resulted into a paradigm shift from basic research to intervention programmes.

Mr. Vice-Chancellor Sir, the issue of protein and energy requirements became a global one in the early 80's. The FAO/WHO *ad hoc* Expert Committee (FAO/WHO 1973) used the factorial method to estimate the safe protein intake for healthy, well-nourished Caucasian males and arrived at a value of 0.57g egg protein/kg body weight as sufficient to meet the needs of nearly all (97.5%) normal adult Caucasians consuming generous energy intakes. The report emphasized the need for comparative studies of endogenous nitrogen losses in different ethnic groups.

Before this, Scrimshaw et al (1972) considered it pertinent to ask whether the results obtained in previous studies with Caucasian university students apply equally to population groups of different racial origins and nutritional backgrounds. Indeed, Huang and Lin (1972) suggested that Chinese men may be able to maintain nitrogen balance at lower levels of nitrogen intake expressed on a body weight or basal metabolic rate basis than similar subjects of Caucasian origin. Furthermore, earlier studies in Nigeria by Nicol who was the Chief Nutrition Adviser to the Government of Nigeria (Nicol and Phillips 1976) suggest that there may be significant ethnic differences in protein requirements, and that populations of developing countries may be more adapted genetically or phenotypically to lower protein intakes than Caucasians. Protein and energy requirement issues, being global, paved the way for my first international collaborative research.

International Collaborative Research

My first international collaborative research was in 1980 on Human Energy and Protein Requirements among male and female subjects in Nigeria. For this epoch making study, I received a grant from United Nations University (UNU) to reassess values for endogenous losses in Nigerian men from the low income group (from Osegere village) and male university students. The results of a factorial calculation of the protein allowance for both the village adults and the

university students were compared with results with those obtained for young adults (FAO/WHO 1973) and adult Nigerian men (Nicol and Phillips 1976) (see table 14). Using the same correlation factors to adjust for efficiency of nitrogen utilization and to cover for individual variability, the calculated protein allowance from our study is much higher than that suggested by the FAO/WHO (1973) report for healthy young adults per kg body-weight (Atinmo, Mbofung, Hussain and Osotimehin 1985).

In the nitrogen balance studies of Atinmo et al (1988) in which diets of different contents were fed to the subjects for 10-day periods, the Net Protein Utilization (NPU) improved from 53 at 0.75g/kg to 91 at 0.3 g over a period of 3-4 weeks. The findings from this study revealed that man's protein requirements are determined to a large extent by his ecological and socio-economic, nutritional, genotypic and phenotypic background.

Table 14: Factorial Determination of Protein Requirements for Various A dult Groups

GROUP	Total mean obligatory[@] (mg/kg per d)	Adjusted N - requirements[#] (mg/kg per d)	Safe Level of Intake[!]	
			N (mg/kg per d)	**Protein (g/kg per d)**
Young Men[$]	54	70	91	0.57
Nigerian Men[%]	62	80	104	0.65
Village Adults[^]	75	97	126	0.78
University Students[^]	69	90	117	0.73

(a)- Total obligatory N loss – urinary N + faecal N + miscellaneous N losses.
#- Obligatory N losses are increased by 30% to account for efficiency of N utilization.
!- Values are adjusted requirement plus 30% to allow for individual variability.
$- From joint FAO/WHO ad hoc Expert Committee (1973).
%- From Nicol & Phillips (1976), assumes miscellaneous N losses to be 5mg N/kg body weight per d according to joint FAO/WHO ad hoc Expert Committee (1973) recommendation.
^- From the present study using a value of 7.46mg N/kg body weight per d as miscellaneous N losses determined for the village adults.(This value was assumed for the university students).

We received additional funding from the Nigerian Institute for Social and Economic Research (NISER) to study the requirements of female adults. In that study, Egun and Atinmo (1993) showed that on a Nigerian diet, women had a lower protein requirement per kg than men, but it was the same when related to lean body mass. The results enabled NISER to develop the food requirements template of the Nigerian population. At the end of the study, I was invited in October 1981, to participate in a two-week FAO/WHO/UNU Expert Consultation Forum on Human Energy and Protein Requirements in Rome, co-chaired by Sir John Waterlow of the London School of Tropical Medicine and Hygiene and Prof Nevin Scrimshaw of the Massachusetts Institute of Technology (MIT). The data from our studies formed the basis for the FAO/WHO/UNU recommendation on human energy and protein requirements published in 1985.

Research of National Relevance

Mr. Vice-Chancellor Sir, one of the advantages derived from the Human Energy and Protein Requirements study was that I received invitations to attend series of international meetings, to discuss more emerging issues on the nutrition situation in Nigeria with international scientists and funders of nutrition related projects in developing countries. At one of these meetings, I had the opportunity of presenting the micro-nutrient situation in Nigeria to a global audience, having conducted pockets of research in this area in my early days. This led the United States Government to ask me, through USAID, to conduct a national micronutrient survey. In 1992, the United States Government provided a grant through the Federal Ministry of Health for the First National Micro-nutrient Survey (1993-1996) in which I was the Principal Investigator. The survey involved nutrition and medical scientists in 12 Colleges of Medicine across the Federation, with Ibadan serving as the headquarters (fig. 2). The medical schools set up their own research teams to conduct the survey in the enumeration areas within their localities.

Countrywide, vitamin A intake was found to be inadequate. Dietary vitamin A intake of preschool children was lower in the northern part of the country than in the South. Almost one in every three children was vitamin A deficient, based on serum retinol levels below 0.7 micromol/L (20μ/dl). The highest prevalence of moderate and severe deficiency was observed in the North Eastern Zone.

1% of children aged 24-71 months were night blind—on the threshold of the WHO cut-off level for defining defi-ciency in young children as a public health problem. Other eye signs of vitamin A deficiency in children were below WHO cut-off points. 1.9% of all women and 2.4% of pregnant women were night blind. Fifty percent of mothers of children with night blindness themselves were night blind. Conjunctival impression cytology (CIC) was less sensitive than other indicators in detecting vitamin A deficiency in this survey. CICs were abnormal in 20.5% of children. Only 30% of night blind children has abnormal CIC readings.

The report of the survey (fig. 3) was presented to the Federal Ministry of Health and it formed the basis for the various intervention programmes on Vitamin A supplementation for child survival.

Fig. 2: Map of Nigeria showing the location of the 12 centres

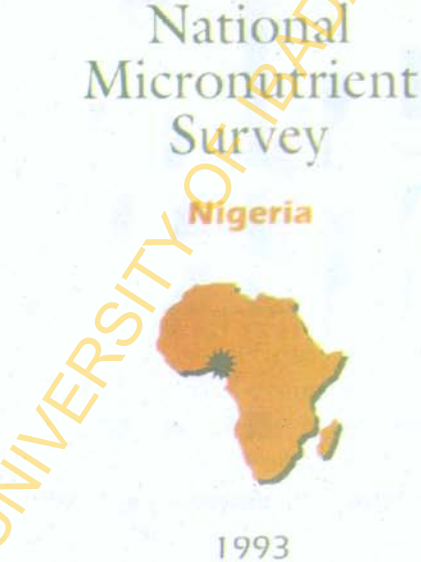

Fig. 3: National Micronutrient Survey Report Publication

This survey used several methods to characterize vitamin A status and assess the risk of vitamin A deficiency. Typically, risk of VAD based on dietary assessment was greatest from 6 – 11 months and from 12 – 23 months compared to later childhood. The dietary consumption index (CI) method consistently showed a lower risk compared with the usual pattern of food consumption (UPFC) method of assessment (see fig. 4). Prevalence of vitamin A deficiency varied greatly by geographic/health zone (fig. 5).

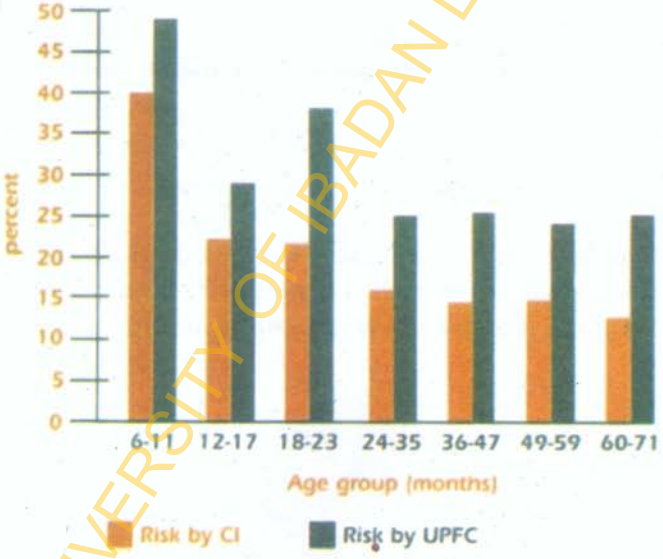

Fig. 4: Vitamin A deficiency by age group.

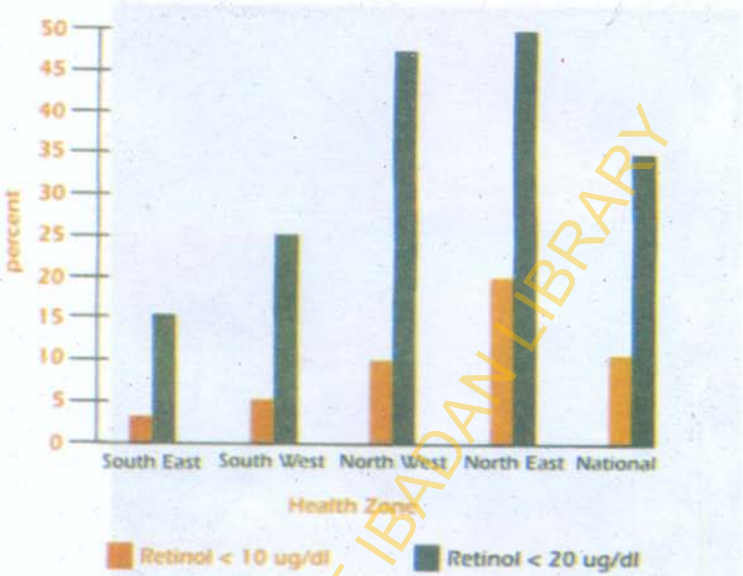

Fig. 5: Vitamin A deficiency by geographic/health zone.

International Network of Expert Consultation in the Field of Human Nutrition

In 2002, I was invited by the World Cancer Research Fund International (WCRFI)/American Institute for Cancer Research (AICR) to join a group of eminent nutrition scientists and epidemiologists to prepare the second WCRF/AICR report on 'Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective' (figs. 6 and 7). The panel was chaired by Sir Michael Marmot of the University College, London and we met thrice in a year for five years (2002 – 2007) in different capitals in Europe and North America.

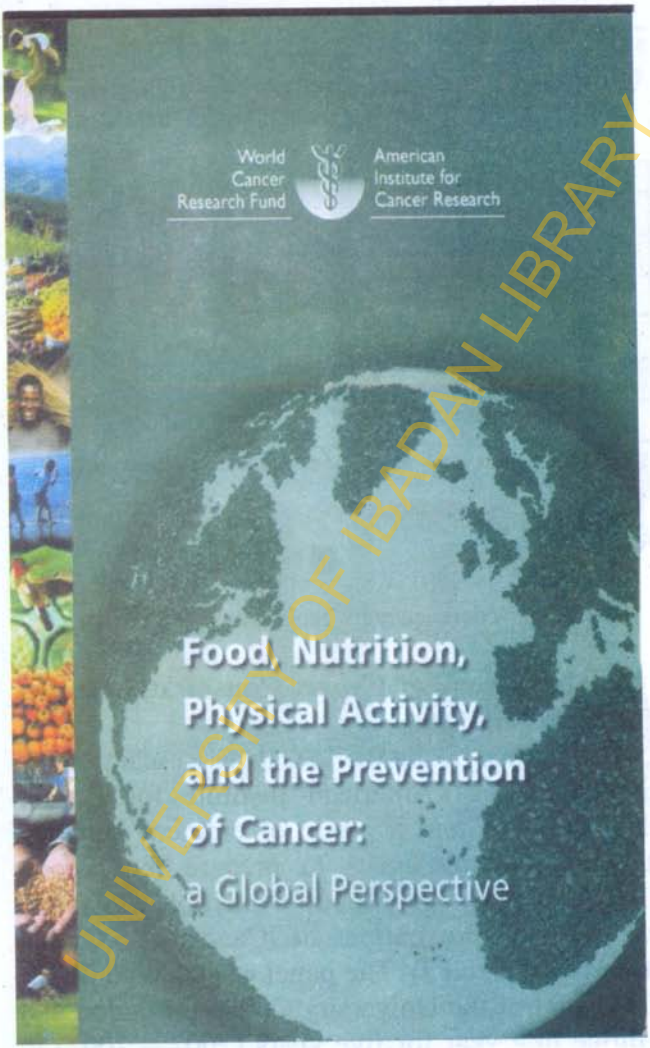

Fig. 6: WCRF/AICR Report Publication

Panel

Sir Michael Marmot
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Chair
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Chapel Hill, NC, USA

Fig. 7: Members of the panel of the WCRF/AICR

The report, published in 2007 (fig. 8), involved over 200 scientists worldwide and was overseen by a panel of 21 internationally recognised experts in the field. The report, which took over five years to complete, systematically analysed more than 7,000 studies on the links between cancer and diet, physical activity and body fat. It found that people who eat a healthy plant-based diet, are physically active and maintain a healthy weight, are at significantly reduced risk of cancer.

General recommendations of the 2007 WCRF/AICR Diet and Cancer Report

BODY FATNESS
Be as lean as possible within the normal range of body weight

PHYSICAL ACTIVITY
Be physically active as part of everyday life

FOODS AND DRINKS THAT PROMOTE WEIGHT GAIN
Limit consumption of energy-dense foods
Avoid sugary drinks

PLANT FOODS
Eat mostly foods of plant origin

ANIMAL FOODS
Limit intake of red meat and avoid processed meat

ALCOHOLIC DRINKS
Limit alcoholic drinks

PRESERVATION, PROCESSING, PREPARATION
Limit consumption of salt
Avoid mouldy cereals (grains) or pulses (legumes)

DIETARY SUPPLEMENTS
Aim to meet nutritional needs through diet alone

BREASTFEEDING
Mothers to breastfeed; children to be breastfed

CANCER SURVIVORS
Follow the recommendations for cancer prevention

The panel was further commissioned to prepare a policy and action report for cancer prevention as an essential guide for everyone who makes decisions or takes action to prevent cancer at international, national or local levels: multinational bodies, civil society organizations, government, industry, media, schools, workplaces and institutions, health and other professionals and individuals (fig. 9).

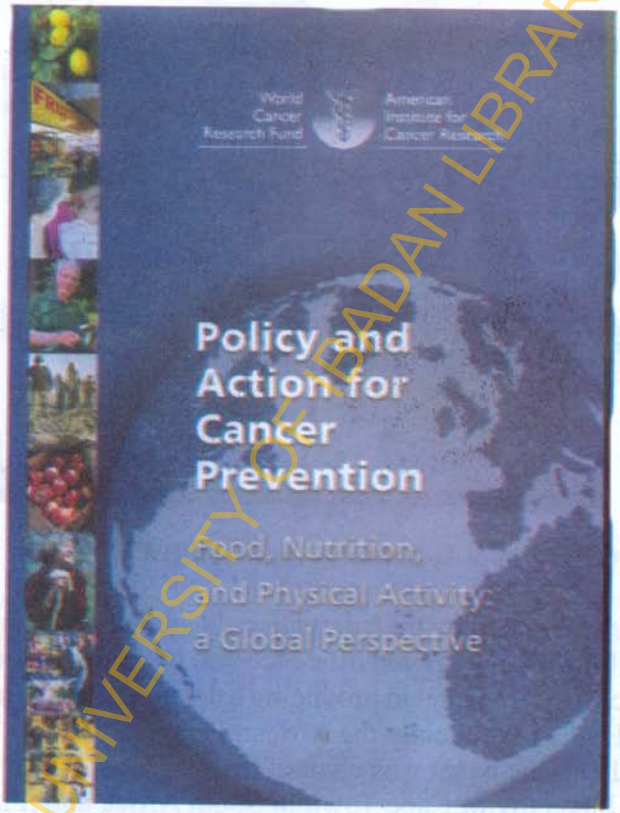

Fig. 9: Policy and action report for the prevention of cancer

In 2002, the Beverage Institute for Health and Wellness (BIHW) which was established by Coca-cola International in Atlanta, invited me to serve as a Member of the Advisory

Council from 2002-2008 (fig. 10). It was chaired by the Vice-President for Scientific Affairs at the Coca Cola Headquarters in Atlanta. We held bi-annual meetings during this period in various cities in the US to advise on BIHW's mission and vision and strategic direction, assist with prioritizing BIHW projects and provide expert advice on clinical study design and implementation, product ideas, nutrition reports and published studies.

Fig. 10: Members of the Advisory Council of BIHW

I was invited by the International Council on Science (ICSU) African regional office located in Pretoria, South Africa to join a panel in producing a document on 'Health and Human Wellbeing: the African Perspective' (figs. 11 and 12). This panel was chaired by Prof Iqbal Parker of the University of Cape Town in South Africa and it met four times from 2006 to 2007 to produce a report that was considered during the 29th ICSU general assembly meeting in Maputo, Mozambique (held for the first time in Africa) in October 2008.

ICSU REGIONAL OFFICE FOR AFRICA

TITLE	**Health and Human Well-being in sub-Saharan Africa**
AUTHORS	**Iqbal Parker [Chair] [South Africa]** Faculty of Health Sciences, University of Cape Town **Tola Atinmo [Nigeria]** Faculty of Public Health, University of Ibadan **Julian May [South Africa]** School of Development Studies, Univeristy of KwaZulu-Natal **Vincent Titanji[Cameroon]** Faculty of Science, University of Buea **Dominic Makawiti [Kenya]** Dean of Medicine, Nairobi University **Fred Wabwire-Mangen [Uganda]** Institute of Public Health, Makarere University **Andrew Githeko [Kenya]** Kenya Medical Research Institue **Neil Koorbanlly [Secretary] [South Africa]** School of Chemistry, Univeristy of KwaZulu-Natal

Fig. 11: ICSU Panel on "Health and Human Wellbeing: The African Perspective"

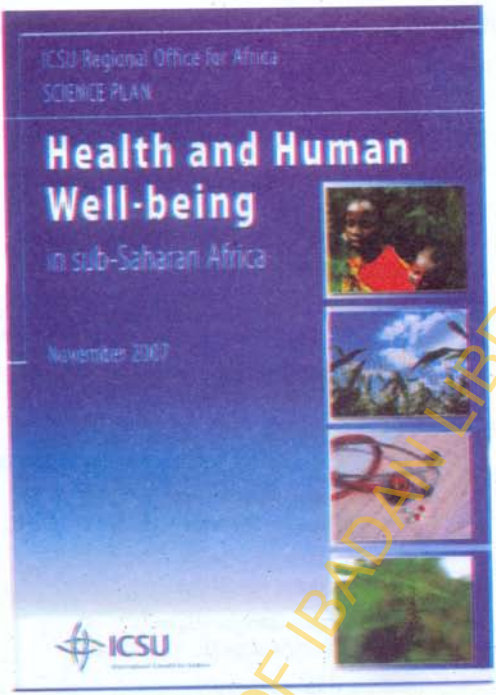

Fig. 12: Publication of ICSU (Africa) report on 'Health and Human Wellbeing'.

Involvement in National Nutrition Issues

Mr. Vice-Chancellor Sir, I championed the first National Conference on Food and Nutrition Policy for Nigeria, which was held in May 1979. The conference was co-chaired by Major-General T. B. Ogundeko, the new Director General of the National Institute for Policy and Strategic Studies (NIPSS), and Professor A. B. Fafunwa, the outgoing Chairman of the National Policy Development Center. The proceedings of this conference were published (fig. 13) with a Foreword by the late former Vice-Chancellor of this premier University, Prof S. O. Olayide, who was also a participant at the conference. The conference was held on the campus of

the University of Ibadan, with three Vice-Chancellors-from Ibadan, Lagos

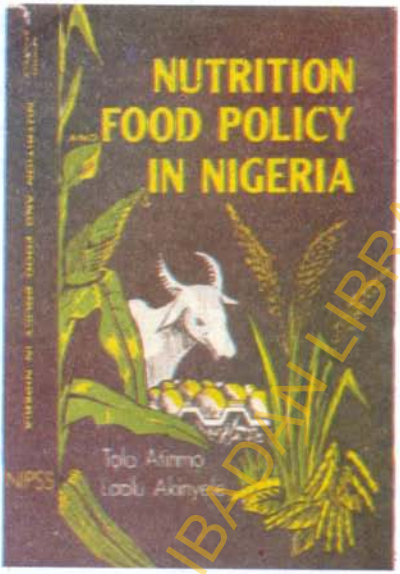

Fig. 13: Publication of the Proceedings of 1st National Conference on Food and Nutrition Policy for Nigeria

The second National Conference on Food and Nutrition Policy for Nigeria was organized in January 1989 by me, and it was held at the National Institute for Policy and Strategic Studies (NIPSS) at Kuru in Jos, Plateau State. This culminated in the establishment of a National Committee on Food and Nutrition, with the mandate to review the nutrition situation in Nigeria and provide the roadmap for intervention. I was the first Chairman of this Committee, which was domiciled at that time under the Ministry of Science and Technology. In 1995, it was relocated to the National Planning Commission, where I was also invited to prepare a draft of National Food and Nutrition Policy for Nigeria (fig. 14). I invited two colleagues (Prof Abiodun Falusi of the

Dept of Agric Economics and Dr Olalekan Olubajo of the Nutrition Division, Federal Ministry of Health) to join me in the preparation of this document. The policy document was accepted and launched in Abuja by the Federal Government of Nigeria in 2002. This policy document became a standard for other African countries to adopt and use as a template for their countries' nutrition policy.

NATIONAL POLICY
ON
FOOD AND NUTRITION
IN
NIGERIA

Produced by
National Planning Commission

2001

Fig. 14: National Policy Document on Food and Nutrition in Nigeria

In October 2006, a group of us met with the then President of the Federal Republic, Chief Olusegun Obasanjo GCFR, to discuss child nutrition situation in Nigeria and the need for government to take urgent action. The delegation

was made up of Prof Adenike Grange who was at that time President of the International Paediatric Association, Prof Ricardo Uauy, President of the International Union of Nutritional Science (IUNS), Prof Orumabo, President of the Paediatric Association of Nigeria (PAN) and myself as President of the Federation of African Nutrition Societies (FANUS). At the end of the consultation, the President agreed to chair a retreat on Child Nutrition Situation in Nigeria which was to involve all stakeholders. The retreat was held in February 2007 at the Aso Rock villa under the chairmanship of President Olusegun Obasanjo, GCFR. Our Department of Human Nutrition had a very strong and powerful presence there. At the end of the retreat, the President summarized the entire proceedings and announced the establishment of a **National Nutrition Council** to be chaired by the President of the Federal Republic of Nigeria and to be domiciled in the Presidency, like the National Economic Council.

This was a milestone in the history of nutrition in Nigeria and it recorded the first time ever that nutrition was accorded the national status it deserves as the cornerstone of any national development agenda. The composition of the Coun-cil, as announced at the retreat by the President, included seven key serving Ministers, representatives of the private sector, professional associations and the civil society. Unfortunately, every attempt to inaugurate the Council before the end of that administration was frustrated by those who continue to neglect nutrition as a cornerstone of a National Development Agenda. However, the President got the Council approved at the Federal Executive Council (FEC) before he left office in May 2007.

Situation after the Retreat

At the end of the tenure of President Obasanjo's administration, the next President, the Late Alhaji Umaru Musa Yar'adua, GCFR, was not able to inaugurate the Council. The hope is that the incumbent, President Goodluck Ebele

Jonathan, GCFR, will show more interest in the child nutrition situation in the country and inaugurate the new Council.

Mr. Vice Chancellor Sir, since nutrition has been a long-neglected cornerstone of our development, the attendant problems are well known. The developed nations have moved beyond the general nutrition issues and are now in the era of Nutrigenomics. I need to state that diseases are better pre-vented and well managed now with the knowledge in this field, as all diseases have a genetic predisposition. Genome-wide association studies (GWASs) by large international consortia are discovering genetic variants that contribute to complex diseases. However, nutrient information is missing, which is essential for the development of dietary advice for the prevention and management of diseases, to improve public health. Non-communicable diseases including all types of diabetes, obesity, cardio-vascular diseases, cancers, among many others, cannot receive proper management if the knowledge of Nutrigenomics is inadequate.

Let me cite a few examples. Our bodies are better adapted to avoid weight loss than to combat weight gain, probably because for thousands of years we evolved under conditions of limited food supply. Key elements in the body weight control system are the processes that control feeding behaviour, which determine the sensations of satiety and hunger depending on an interplay between internal signals (such as leptin) and environmental factors, and the processes that control energy efficiency, which can be physiologically regulated making it possible to dissipate part of the energy contained in food as heat instead of accumulating it as fat. Other important elements in this system are the control of adipogenesis, the process by which pre-adipose cells are converted into mature adipocytes, and the control of nutrient partitioning between tissues and metabolic pathways, which greatly conditions the possibilities of adipose tissue growth. Overweight, obesity and related medical complications can occur as a result of genetic or acquired changes in any of these processes. There is an increasing body of knowledge on how different food components act on specific targets in this

system that is influenced by a number of genetic variants in more than 400 genes and how the metabolic history affects the predisposition to develop the obesity-associated medical problems. However, obesity, though paradigmatic, is only one example; major challenges for Nutrigenomic research in the next decade are to identify cause/effect relationships between multiple genome variations, diet and other environmental factors, and the main chronic diseases.

Nutrigenetics/nutrigenomics could provide a framework for development of genotype-dependent novel foods for health promotion and for prevention and management of chronic diseases. Many developed countries have compiled national general dietary guidelines for the prevention of chronic diseases without considering the effects of genetic variation on dietary responses, despite available evidence (Molloy et al. 1997; Zeisel 2008). Nigeria can avoid this type of oversight when such document is being produced. Moreover, there is a glaring need for the integration of a deeper knowledge of nutrition into our medical curriculum to expose medical practitioners to basic nutrition training. This will assist in ensuring that patients receive a more holistic treatment that will take into cognizance critical aspects of care, of which nutrition is germane. Along this line, Oyewole and Atinmo published a paper in 2008 to reflect the need to include nutrition as part of the medical training curriculum.

Recommendations

Mr. Vice-Chancellor Sir, an inaugural lecture will not be complete without making some salient recommendations and this one will not be an exception. On this basis, I will premise my recommendations on some issues.

The reason why nutritional problems still persist at high levels in many developing countries including Nigeria is not that we do not know how to reduce them, nor that these countries have applied best practice, yet failed to succeed. The reason is that most countries have not invested on a scale large enough to get these tested technologies to those who

will benefit from them most. In addition, many countries that have invested have either used less effective and less strategic interventions (such as school feeding), or have not paid attention to the quality of implementation.

The window of opportunity for improving nutrition is small—from pre-pregnancy through the first two years of life, the first 1000 days. There is the consensus that the damage to physical growth, brain development, and human capital formation that occurs during this period is extensive and largely irreversible. Therefore, interventions must focus on this window of opportunity. Any investment after this critical period is much less likely to improve nutritional wellbeing.

Improving maternal knowledge, feeding, and adequate care during pregnancy (to address low birth weight) and lactation, and improving infant feeding and caring practices, such as exclusive breastfeeding and adequate and timely complementary feeding, are critical to improving nutrition outcomes. These tasks are closely linked to issues of gender.

Efforts should be geared towards increasing the availability of appropriate foods at affordable prices, improving access to micronutrients, and improving basic health services—immunization, for example, prevents diseases that retard children's growth. There is need for changes in behavioural practices related to what is eaten and fed, and to workloads and exercise. Most nutrition interventions require changing eating, feeding, or exercise behaviours to have an effect. The fact that some poor children are adequately nourished and many non-poor children are malnourished emphasizes the critical importance of child-care behaviour. Provision of micronutrient supplements or food supplements for children, pregnant and lactating women should be pursued with vigour.

Genetics should not remain the exclusive prerogative of geneticists. Instead, every nutritionist and physician will need to learn to evaluate and explain genetic knowledge about their patients and combine it with an appropriate dietary regimen, the type and amount of physical activity, and, if needed,

pharmaceuticals. Public health professionals will utilize genetic information to identify population subgroups with significantly different responses to diet, infection, and environmental exposures. Genotyping should become part of the management routine of an expanding range of human diseases, and nutrigenetics will supplement pharmacogenetics. Knowing who is at risk would be useful if it means that one could avoid the environmental triggers (including some food items) that convert susceptibility into disease.

Increased physical activity and recommended diets balanced in essential nutrients ratios can be the pillars for health promotion and prevention of multiple chronic diseases.

Conclusion

Mr. Vice-Chancellor Sir, A combination of food, fuel and financial crises is threatening the livelihoods and food security of millions of people in Nigeria, albeit heightening political interest in undernutrition. Repositioning nutrition as a central pillar of development has opened a window of opportunity to catalyse change in the national nutrition architecture. Political interest in nutrition has been further heightened by a concern that the Millennium Development Goals (MDGs) are unlikely to be achieved by the target date of 2015, and a growing recognition that adequate nutrition is a crucial input to help get five out of the eight goals back on track.

The central role of nutrition in development was also recognized in the 2005 Report of the Commission for Africa and at Copenhagen Consensus 2008 when the expert panel of economists identified undernutrition as the biggest challenge facing the world, and the delivery of micronutrients as the most cost-effective intervention that could be made. The current crises have exacerbated the impact of long-standing under-investment in nutrition programming; and child undernutrition is now highly prevalent in Nigeria and other developing countries, resulting in substantial increases in mortality and overall disease burden.

There is very strong evidence that undernourished children are more likely to be below average height when they reach adulthood, to have lower educational achievement, to give birth to smaller infants and have lower economic status in adulthood, with effects that spill over to future generations. These findings are a wake-up call to the Presidency, the Finance Ministry and development agencies in Nigeria (with a high burden of undernutrition) showing that adequate nutrition in early life (the first 1000 days from the pre-pregnancy period) is a prerequisite for human capital formation and economic development.

Undernutrition is a gigantic problem but it is accorded a low national priority in Nigeria. The key constraint appears to be the absence of effective nutrition advocacy coalitions in Nigeria to build national commitment to overcoming undernutrition. As such, there is little demand on government agencies in each sector to be accountable for assisting the undernourished. Whilst not minimizing the difficulties, there are several actions that advocacy coalitions can take to raise the profile of undernutrition as a national development problem. The key challenges are,

- to use evidence based advocacy to increase recognition of the link between the many interventions and child undernutrition;
- to gain acceptance of nutrition as a governance issue; and
- to increase demand side factors to make the government accountable for undernutrition.

Mr. Vice-Chancellor Sir, as we advance our knowledge of gene-nutrient interaction, society will need to create or utilize appropriate social, ethical, legal, educational and economic frameworks to gain the benefits of such knowledge.

Acknowledgements

I wish to start by giving all the glory and honour to the Almighty God who has kept me to this day and by whose

grace and special favour I am what I am today. I thank my late parents Mr Joseph Badejo Atinmo and Mrs Sabina Titilola Atinmo (nee Onagoruwa) for the Christian discipline they instilled in us very early in life. I lost my father during my first year in the university and it was like all hope was lost but my mother stood like a Titan to ensure that my siblings and I not only completed our undergraduate education, but also our postgraduate programmes in the United States. May their souls continue to rest in perfect peace. Amen.

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In the past 35 years that I have been a staff in the Department of Human Nutrition, I have had the fortune to supervise very many students at the B Sc, M Sc, M Phil and Ph D levels. I appreciate each one of them. They have been wonderful to me. Those who have completed their Ph D studies under my supervision include Professor Carl Mbofung, head of the Department of Nutrition and Food Science, University of Ngaundere, Cameroons, Dr Gloria Elemo, Director, Federal Institute of Industrial Research, Oshodi (FIIRO), Dr Dupe Adeniran, Deputy Director, National Universities Commission, Dr Mugisha, Makerere University, Uganda, Professor Ademola Amosu, Lead University, Ibadan and Dr (Mrs) Olumakaiye, lecturer at the Obafemi Awolowo University, Ile Ife.

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I have spent the last two years at the Department of Biochemistry, Olabisi Onabanjo University, Ikenne Campus. It has been a different experience for me and I want to thank all those dedicated staff in that University for their loyalty to the Institution and their hope for a better tomorrow.

I worked with a dedicated and committed team in Ibadan during the first Nigeria National Micronutrient Survey from 1992-1996. My appreciation goes to Professors Babatunde Osotimehin, Yemi Omotade, Tunde Ajaiyeoba, Drs Iyabo Adeyefa, Lola Dare, and Debo Adeyemo for their devotion to duty.

Mr Vice-Chancellor Sir, I have had the fortune and priviledge to attend the best schools Nigeria has to offer—King's College, Lagos and the first and best university, the University of Ibadan. I also attended an Ivy League university in the United States of America- Cornell University, Ithaca, New York. These institutions have moulded me in the spirit of 'Yes we can.' I want to thank my classmates at King's College, especially the 'Golden Ingots.' More than 20 of us (out of a class of 60) ended up being professors in various universities. Floreat!

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Mr. Vice-Chancellor Sir, this is my story. To God be the glory.

I thank you all for your attention.

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BIODATA OF PROFESSOR TOLA ATINMO

The fourteenth in the series of the University Inaugural Lectures for 2009/2010 session will be delivered by Professor Taiwo Jokotola Atinmo of the Department of Human Nutrition, on behalf of the Faculty of Public Health, College of Medicine.

Taiwo Jokotola Atinmo was born in Lagos on the 29th day of January 1945. He attended Ereko Methodist Primary School, Lagos from 1950 to 1957 and later went to Kings College, Lagos, for his secondary and higher school certificate education from 1958 to 1965. He secured admission into the premier University of Ibadan in 1966 and graduated in 1970 with a BSc Degree in Agricultural Biochemistry and Nutrition, Second Class Upper Division.

He proceeded to the United States of America in August 1971 to study Nutrition at the famous Graduate School of Nutrition at Cornell University, Ithaca, New York. Professor Atinmo obtained his Masters of Nutritional Sciences (MNS) in 1973 and a PhD in Nutrition in 1975 from Cornell University. He joined the Department of Human Nutrition of the University of Ibadan in September 1975 as a Temporary Lecturer II and was appointed Lecturer I in June 1976. He became a Senior Lecturer in October 1978 and a Reader in 1983. He was promoted to the grade of a full Professor of Human Nutrition in October 1985. He served as Head of the Department of Human Nutrition of the University of Ibadan from 1987-1988, 1995 -1998 and from 2004 - 2007.

Prof Atinmo has served as a consultant and food and nutrition project manager for many multilateral and bilateral agencies including the World Bank, FAO, UNICEF, WHO, UNESCO, UNU and USAID. He was the Principal Investigator of the USAID funded first Nigeria National Micronutrient Survey in 1992. He was the President of the Nutrition Society of Nigeria between 1986 and 1990 and currently serves on the Board of Trustees of the Society with other eminent Nigerians. In 2001, he was elected to the

Council of the International Union of Nutritional Sciences (IUNS), and he is the current President of the Federation of African Nutrition Societies (FANUS).

In 1995, Prof Atinmo was commissioned by the National Planning Commission to prepare a draft National Food and Nutrition Policy for Nigeria. He was the foundation Chairman of the National Committee on Food and Nutrition (NCFN) under the Federal Ministry of Science and Technology in October 1990.

Professor Atinmo is a member of the expert panel of the World Cancer Research Fund International, and is on the Advisory Board of the Beverage Institute for Health and Wellness established by Coca Cola International based in Atlanta, Georgia, USA. He is also a member of the National Nutrition Council, chaired by the President of the Federal Republic of Nigeria. He serves as the Chairman of the Technical Committee of the Council. In February 2008, he was honored by the Cameroon Nutrition Society in Yaoundé with a Lifetime Achievement Award in recognition of his monumental services in the area of Nutrition in the African continent. He had earlier, in 2006, been similarly honored by the Ghana Nutrition Society.

Professor Atinmo is a Knight of John Wesley of the Methodist Church, Nigeria. He is the current Chairman of the Sigma Foundation, and a Fellow of the International Academy of Food Science and Technology (IAFoST). He is married with children.