J. Basic. Appl. Sci. Res., 3(11)378-387, 2013
© 2013, TextRoad Publication
ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

Career Path in Public Health in the Age of Genomic Science

E. William Ebomoyi, Ph.D. Professor

Department of Health Studies, College of Health Sciences
Chicago State University
Chicago, Illinois 60628-1598

Received: September 3 2013
Accepted: October 10 2013

ABSTRACT

This project focuses on the accomplishment of the human genome sequencing project (HGSP), and the various innovative careers which have been derived from genomics. In the G-8 nations, the several medical and public health disciplines which have been developed from genomics related interventions are directed at maximizing public health and minimizing public harm. Besides, the numerous innovative careers; the responsibilities of the new public health genomic scientists will occur in microbial genomics, genomic epidemiology, nutritional sciences, bio-processing and in bio-informatics and molecular biology (sequencers) among others. In the G-8 nations, before accomplishing the HGSP, numerous innovative technological infrastructures were developed, and the scientific workforce existed to collaborate with numerous biotechnological companies, therefore, the added economic, medical and public benefits will out-space the cost of introducing genomics to the developing and the least-developing nations. This project has identified potential career path for public health in the industrialized nations, compared to the potential careers in public health in the developing and the least developing nations. Also outlined, are the relevance of revising the curriculum for didactic instruction of students of public health worldwide. Suggestions were advanced to integrate knowledge about genomic technology into the curriculum of public health scientists in the developing and the least developing nations.

KEYWORDS: Definition of public health and genomic science, Impact of sequencing the human genome on public health, Identification of innovative careers created from genomic interventions, The tripartite linkages among public health, preventive medicine and health education, Potential role and responsibilities of genomic epidemiologists and role of health educators in genomic age

INTRODUCTION

Among the various scientists and political leaders who supported the initiative to sequence the human genome, efforts were made to ensure that the accomplishment of the project coincided with the celebration of the 50th anniversary of James D. Watson and Francis Crick's discovery of the double–helical structure of deoxyribonucleic acid (DNA). It is on record that by April12, 2003, world leaders from six economically powerful nations with five of them from the G-8 nations and only one from a progressive developing nation supported this project. The heads of government of six nations which contributed to the sequencing initiatives were United States, The United Kingdom, Japan, France, Germany, France and China. They issued a joint proclamation which was transmitted worldwide: "the essential sequencing of three billion base pairs of DNA of the Human Genome, the molecular instruction book of human life," had been achieved(Department of Trade 2003). Scientists who participated in this unimaginable feat compared their accomplishment to the Apollo moon landing and the splitting of the atom, leading to the dawn of a new era, "the era of genomic medicine; the era of public health genomics and the era of biological pre-eminence."[1]

The predictions were that everyone worldwide, will be affected by the spin-off benefits of technologies associated with genomics. Besides, when on-going research and biotechnology developments are fully implemented, the current medical practice will become obsolete. Understanding of human genetics and genomic profile will create the foundation for intense research in innovative medicine, agriculture and the various biologic sub-disciplines which could illuminate the inner workings of the entire human biological systems. Patrinos [2], admitted that sequencing the human genome was a pioneering venture with risks and uncertainties. Walport [3] of the Wellcome Trust remarked that the enormity of the Human Genome Project is unprecedented in biology and he praised the international vision and collaboration of the scientists who were involved in this global scientific breakthrough.

In spite of the accomplishment of the Human Genome Sequencing Project(HGSP) by March, 13, 2003, the other medical and public health initiative of similar international magnitude was the concept of "Health For All by The Year 2000." This program which was launched by the United Nations, World Health Assembly (WHA) by May

*Corresponding Author: E. William Ebomoyi, Ph.D. Professor, Department of Health Studies, College of Health Sciences, Chicago State University, Chicago, Illinois 60628-1598. eebomoyi@csu.edu

1979, involved over 193 member nations of WHO. This august body had declared an overriding priority for the attainment by all peoples of the world, the highest possible level of health. The World Health Organization (WHO) further explained that "health for all" meant that as a minimum, everyone in all countries of the world should have at least a level of health so that they are capable of working productively and participating actively in the social life of the community in which they live. To achieve this level of health, every individual should have access to primary health care and through it to all levels of comprehensive health care system[4] The WHO[4] echoed specific caveats; even though countries might be expected to have a similar but un-identical general understanding of the meaning of "health for All', each nation will interpret it in light of its own social and economic characteristics, health status, morbidity patterns of its population and the level of development of its health system(WHO 1978)[4] Although many health administrators and political leaders, worldwide initiated policies directed at improving the health status of their citizens, we must emphasize, even in the twenty-first century, there had not been any other laudable and comprehensive program similar to the primary health care program launched by the World Health Organization in 1978. The tenets of WHO-sponsored primary health care advocated a standard of health for everyone on earth, without distinction of race, religion, political belief or economic or social condition. The ministers of health in each of the WHO-member nations played significant role in the aggressive and comprehensive implementation of primary health care activities and the use of inter-sectorial collaboration to ameliorate PHC program implementation in the urban, rural and hitherto geographically isolated villages worldwide. Whereas in the implementation of the HGSP, most of the the centers involved in the sequencing were from the G-8 nations (90%), and only one from a developing nation, specifically, the Beijing Genomic Institute (BGI) in China. However, Canada, Italy and Russia were not among the industrialized nations that co-sponsored the sequencing of the human genome project. The observations made by the international scientific community focuses on the reality that many of the numerous advances developed in genomics were made and to a large extent owned by the developed G-8 nations. Strategically, this has given rise to the trepidations that global genomics disparities could be created which could further widen the economic and health imbalance and the equity gap between the industrialized affluent nations and the developing and the least developed nations[4] In the opinion of WHO[4] and Pang, Singer and Daar [5], genomics and related technologies should be used to bridge the existing gap, and eliminate the existing unethical inequalities in global health. The World Health Organizations [6] released a report by 2002 which focused on this inequity. It stated that approximately 80% of investments in genomics in 2000 came from the United States and 80% of the DNA patents in genomics in the period 1980 through 1993 were held by US companies[5] Unfortunately, of the 1233 hew drugs marketed between 1975 and 1999, only 13 were approved specifically for tropical diseases.[5].

The lag-time regarding the involvement of the international health organizations and their member nations from the developing and the least developing nations has created the inertia in participating in human genome research sequencing activities. Besides the trepidations among scientists in the developing and the least developing nations some of the tantalizing unresolved issues include: (1) how do international scientists and world leaders facilitate the diffusion of the medical, public health and economic benefits derived from genomics, (2) What are the ethical, legal, social and financial implications of introducing genomics research to the developing and the least developing nations, (3) how do the international health organizations, and global financial institutions ensure that knowledge derived from genomics does not trigger income inequalities, (4) can genomics programs be implemented in the industrialized nations without necessarily widening and creating enormous imbalance between the economically affluent G-8 nations and their resource-starved developing and the least developing impoverished nations?

Only ten years after the accomplishment of the HGSP, in the G-8 nations, the practical value-added benefits from genomics are being realized in agriculture, forensics, identification science, microbial ecology, toxic waste management, and the mysteries of evolution, anthropology, sociology, and human migration patterns [6]. Currently, economists continue to publicize how genomics and biotechnology now have profound impact on engineering, computer science, mathematics, ethics, sociology, law, agriculture, education, pharmaceutical applications, instrumentation, nuclear medicine, forensic science, bioremediation, bio-fuels, and journalism. In genomic community, as we celebrate the medical, public health and technological benefits associated with genomics, daunting challenges continue to emerge.

Fig. 1-The G-8 Nations with the participation of only five member nations

Participants in HGSP:- United States, United kingdom, Japan, France, Germany

Less than ten years into the accomplishment of the HGSP, numerous technological infrastructures used for innovative genomic sciences were developed and commercialized to facilitate diagnostic medical services. Numerous public health benefits are being realized in the G-8 nations and a few of the progressive and technologically advanced, developing nations such as Brazil, Russia, India, China, South Africa(the BRICKS) have also capitalized on using genomics to enhance their national public health programs. As the enthusiasm about genomics surged, the promise of this unprecedented scientific feat was that everyone regardless of race, citizenship, national origin would reap the benefits of genomics and the multifarious applications. There would be increased life expectancy, low infant mortality rate, remunerative career prospects for young graduates and improved health status for newborns and their mothers.

The other concerns expressed in most of the developing nations and the least developing nations are many and varied: they have echoed their financial indebtedness to the International Monetary Fund (IMF), the World Bank and to most of the affluent G-8 nations. They also indicate similar set-backs regarding lack of scientific infrastructures to harness the benefits of research derived from genomics, and their challenges of insufficient financial capital to establish viable comprehensive genomic sequencing centers and inadequately trained workforce to conduct rigorous and meaningful research in medicine, agriculture, and plant genomics, bio-processing and other value added economic outcomes associated with genomics. Against this background, this project was designed to:

- Predict global ecological events which could influence career path in public health
- Identify innovative career path in public health in the G-8 nation
- Identify relevant career path in the developing nations
- Discuss unique and appropriate career path in the least developing nations
- Discuss the relevance of innovative public health curriculum in the age of genomic science
- Accentuate a didactic and an eclectic preparation of public health professionals

The United States Institute of Medicine (IOM) defined genomics as “the study of the entire human genome. The Expert Committee at IOM also emphasized the potential benefits of genomics in improving the health of the public by differentiating genomics from genetics. The latter focuses on the study of functions and effects of single genes while the former explores not only the actions of single genes, but also the interactions of multiple genes with each other and with the environment [7]. However, from molecular biological perspective, genomics was conceptualized as “the comparative analysis of complete genome sequences from different organisms and the determination of global patterns of gene expression; used to assess evolutionary relations among species and the prediction of the frequencies and general types of RNAs produced by an organism. Genome is the total number of genetic information carried by a cell or an organism [8].

By 2004, the IOM[9] charged the committee on Educating Public Health Professionals for the 21st Century to develop a framework to strengthen education, training and research in the schools of Public Health. To achieve an

optimum success, the committee was assigned the responsibility of reviewing the current state of public health education, didactic training, and research capability, define the areas in need of modification or complete change, to best prepare the nation's future public health workforce. They were to translate their findings into actionable objectives that can assist public health educators in responding to the challenges facing public health; and (4) disseminate their results throughout the report. Following the review of (1)the catalogues of twenty nine schools, of public health to glean information on graduate degrees available, and most frequently offered courses and the content; (2) survey twenty-five schools of public health; (3) review the catalogues of 29 schools of public health to abstract information on graduate degrees available and most frequently offered courses.(4) They made specific recommendations. Besides, they also -interviewed representatives of the Association of Schools of Public Health, Association of State and Territorial Health Officials, Centers for Disease Control and Prevention, National Association of County and City Health Officials, and the Public Health Foundation. Specifically, the meetings held involved numerous public and private institutions and pharmaceutical companies, the media, public health professionals, medical nursing professionals and students. Each meeting was led by the representative of Robert Wood Johnson Foundation. The committee and project staff published their findings in a report entitled: "*Who Will Keep the Public Healthy? Educating Public Health Professionals for the 21st Century.*" This report itemized the recommendations and conclusions for improving public health professional education, training, research and leadership. After this comprehensive review and critical analysis, the committee recommended their resolutions"[9]

The Institute of Medicine (IOM) outlined the singular importance public health education which should be based on ecological model of health. From national and international perspectives ecological events occur uncontrollably and they influence myriad human interactions, global and national commerce on a regular basis, therefore IOM recommended beside the long-recognized five core components of public health (epidemiology, biostatistics, environmental health, health services administration, and social and behavioral science); it should also encompass eight critical new areas which include: informatics, genomics, communication, cultural competence, community-based participatory research, policy and law, global health, and ethics. A voluntary certification program in the ecological approach to public health should be developed as a way to encourage new master of public health (M.P.H.) graduates to increase their competence (IOM)[9].

Public health is so crucial to the survival of any nation and the global community that the World Health Organization over sixty five years ago, defined health as "a state of complete physical, mental, and social wellbeing and not merely the absence of diseases or infirmity."[3] Philosophically Rene Dubos [10] endorsed this definition by arguing the WHO version of health creates an enviable aspiration for the neonate borne into an environment where such a child can be borne into an environment in which as a result of global genomic interventions, the deadly parasitic diseases and viral agents and lethal emerging and re-emerging diseases may have been eradicated or drastically controlled. From epidemiological perspectives, such newborns are able to achieve their full genetic endowment. On the other hand Larry Green [11] was of the opinion, that wellbeing particularly social wellbeing requires for its meaning an understanding of the historical circumstances that have caused a given community to accept some conditions that another community would perceive or characterize as unacceptable. The resolution to such analysis lies in the phenomenological background, socio-cultural nuances and other social demographical characteristics of people who live in different parts of the world and their uniqueness. In similar vein, public health as a discipline must reflect the existing philosophical leanings in an area, religious affiliations, and economic status of an area, existing wealth or poverty in an area, the nature of government acceptable to the people, the inherent educational system, scientific /technological status and the aspiration and folklore of any given period [11].

Human Ecological Events and Public Health

Between the twentieth and twenty-first centuries, scientists have been unable to forecast with epidemiological precision the myriad ecological events most likely to unleash their deadly impact on the global community. In recent times, by December 24, 2004, the earthquake and tsunami which occurred in Indian Ocean led to a violent movement of the earth crust known as the tectonic plates which displaced an enormous amount of water, propelling powerful shock waves in virtually every direction. As reported by Google.com and Yahoo sources in 2013, the catastrophic impact from the Asian Tsunami led to between 230,000-275000 mortality and morbidity with over 1000 declared missing. By August 23, 2005, when the hurricane Katrina struck Louisiana with devastating impact on gulf states, over 1,836 lives were lost with more than 1000 missing.

It must be recognized that we are at the mercy of natural ecological events and man-made disasters which shape the development of public health curriculum, and the innovative training of the new generation of public health professionals. In the highly industrialized G-8 nations, led by the United States, many observable natural disasters and man-made horrific events have given rise to the development of multiple career paths in the twenty first century. Such crucial careers in public health disciplines include:

- Microbial genome epidemiologists, modern genome epidemiologists
- Bio-terrorism specialist, military, public health microbiologists
- HIV/AIDS Peer educator, Chronic and degenerative disease patient educator
- Global warming abatement specialists, community health educators
- Modern genome public health nutritionists
- Industrial hygienist, Health data analyst.
- Bioinformatics specialists/health informatics scientists
- Public health safety officer
- Hospital epidemiologists
- Air quality specialist
- Public Health-GIS geographers

Relevant traditional career paths in public health in the developing nations*:*

A list of developing nations which are members of the G-20 include European Union, Brazil, china, France, India, Italy, Mexico, Saudi Arabia, Republic of Korea, United Kingdom, Australia, Canada, Argentina, Germany, Indonesia, Japan, Russia, South Africa, Turkey, and United States of America. In many of the developing nations, the international framework utilized for public health programs were principally derived from the definition of public health by Charles –Edward A. Winslow [12], a prominent leader of the American public health discipline, during the first half of the twentieth century. By 1920, he defined public health as:

> The science and the art of preventing disease, prolonging life, and promoting physical health and efficiency through organized community efforts for the sanitation of the environment, the control of community infections, the education of the individual in principles of personal hygiene, the organization of medical and nursing services for the early diagnosis and preventive treatment of disease, and the development of the social machinery which will ensure to every individual in the community a standard of living adequate for the maintenance of health[12].

From Winslow's [12] perspectives, public health overlaps several aspects of medical sciences, nursing, school health, and disease prevention. In many societies particularly in the developing and the least developing nations, health is associated not only with the work of government agencies but inextricably linked with community health promotion and structural interventions. In the following decades into the twenty first century, public health initiatives yielded multifarious dividends based on the definition enunciated by Winslow. It led to a reduction in infant mortality rate; it drastically reduced the prevalence of parasitic diseases, and it enhanced the life-expectancy of Americans. In Winslow's era, the career paths which were developed included the following:

- Public health microbiologists, Sanitarians, Veterinary scientists and community health workers and epidemiologists.
- School health educator, school health officer, public health nurse
- Environmental health educator, evaluator
- Public health administrator, Health policy analyst
- Health economist, Demographers, Health service researchers
- Sanitary engineers, food hygienists, Biochemists

Winslow's philosophical construct facilitated the development of core courses in public health which eventually gave rise to the eradication of deadly infectious diseases such as smallpox, measles, yaws, and other infectious diseases, which ultimately increased lifespan of Americans by several decades. But by 1980, the impact of Winslow's public health vision continued to wane as the number of the elderly with chronic and degenerative diseases surged. The statistics of teenage pregnancies increased, drug use behavior and youth violence became intractable national public health concerns. The outbreak of HIV/AIDS as an incurable emerging infectious disease, became not only a national issues but an international challenge. Again, the United States Institute of Medicine (IOM)[9] was compelled to refocus national and international attention on the importance of public health in order to revitalize the field just as the non-profit agency has ingeniously confronted similar arduous responsibility in the age of genomic science. The public health challenges encountered in United States and other G-8 nations are similar but rather un-identical to the endemic problems encountered in the developing and least developing nations. The disparity is the former has applied technology and public health interventional mechanisms to constantly address their endemic public health issues while the latter is resource starved and technologically underdeveloped.

Unique and appropriate career path in public health in the least developing nations

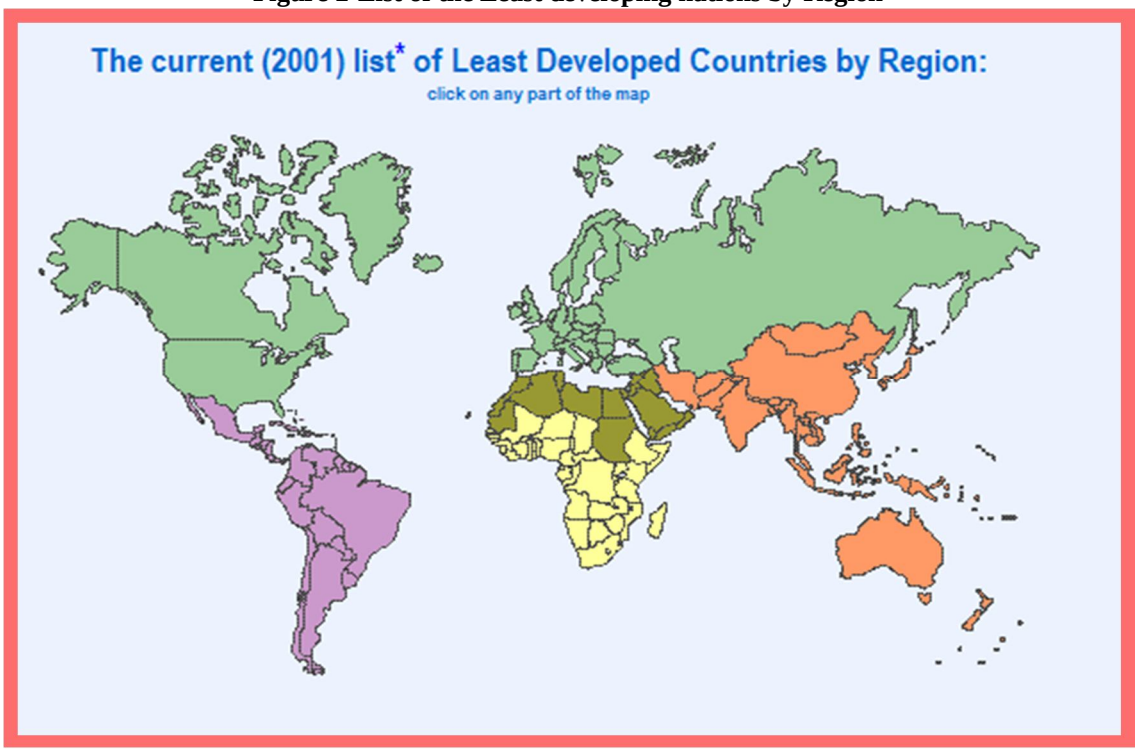
The list of the least developing nations reported by the United Nations using demographic and economic indices include the following: Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia,

Central African Republic, Chad, Comoros, Congo(Democratic Republic of the Congo), Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Haiti, Madagascar, Malawi, Mali, Mozambique, Myanmar, Nepal, Niger, Rwanda, Samoa, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, Sudan, Timor-Leste, Togo, Tuvalu, Uganda, Kiribati, Lao People's Democratic Republic Lesotho, Liberia, United Republic of Tanzania, Vanuatu, Yemen and Zambia. Of these least developing nations, 34 of them are in Africa, one in America and the others in Asia

The leading causes of disease burden in these least developing nations are lower respiratory infections, diarrheal diseases, conditions arising during the perinatal period, uni-polar major depression, tuberculosis, measles malaria, ischemic heart disease, congenital anomalies and cerebro-vascular diseases [13]. Public health genomics and medical interventions can play significant role in either eliminating or significantly reducing the prevalence of those diseases categorized parasitic diseases. Although the World Health Organization focused on the control of these diseases since 1978, with limited success, the five public health problems targeted were: malaria, schistosomiasis, filariasis, trypanosomiasis, and leishmaniasis and possibly leprosy. Three prominent rationales provided for selecting the diseases include: (1) That they are widespread and in some cases have the potential of affecting everyone in many developing nation thereby constituting a serious public health problem (2) There are no satisfactory methods of control of these diseases in the prevailing circumstances of the tropical nations and (3) They greatly impede socio-economic development and drastically reduce human life-expectancies [14].

In fact, in 1978, Dr. James D Watson [14] the Nobel laureate described these parasitic diseases as "public enemy number one." Although Lucas[15], the former director of WHO Tropical Disease Research(TDR) program maintained that the provision of pipe-borne water to the rural areas could immediately eliminate over 75% of these infectious diseases, which contribute to the untimely mortality and morbidity of people in tropical areas, the budget stipulated for the control of these diseases is usually inadequate. Malaria which kills more children in Sub-Sahara African than HIV can be controlled by developing good drainage systems to eliminate mosquito-breeding sites and introducing strategies for reducing the contact of the vectors to people in endemic regions[14,15,].

Figure 2-List of the Least developing nations by Region



In the least developing and most of the developing nations, the development of public health workforce must address the challenge of capacity building in the following public health disciplines**:** public health microbiology sanitarians, veterinary science and community health education and epidemiology, School health education public health nursing, environmental health education, evaluation public health administration, health policy analysis health economics, demography, Health service research, sanitary engineering, food science, biochemistry.

Public health curriculum in the age of genomic science

In order for public health to maintain its pre-eminence in minimizing harm and maximizing human health, in addition to the core courses recommended by the Institute of Medicine the graduates and potential students from the schools of public health must have the competence to confront the broad spectrum of the current leading causes of diseases in United States and those predicted to occur even by the year 2020.The five predicted, possible, leading causes of death in the world by 2020 will comprise ischaemic heart diseases, unipolar major depression, cerebrovascular diseases chronic obstructive pulmonary diseases lower respiratory infections and tuberculosis among others (Figure 3).[16] An innovative public health curriculum must be comprehensive and tailored in to meet the needs of any nation; targeting the endemic diseases in such nations.

The eclectic preparation of the potential public health professionals

In order to ensure that health education of the public in the age of genomic science become responsive to national and international disease burden, evidenced-based health education program must target the following diseases: Apolipoprotein(a) excess, apolipoprotein Al deficiency, autosomal recessive hypercholesterolemia, cerebrotendinous xanthomatosis, Fabry disease, familial combined hyperlipidemia, familial defective apoB, familial hypercholesterolemia, Familial partial lipodystrophy, Familial pseudo hyperkalemia due to RBC leak, heparin cofactor II deficiency, homocystinuria/homoysteinemia, niemann-Pick disease, type E, Progeria, Protein C deficiency, pseudoxanthoma elasticum, sitosterolemia, spontaneous coronary dissection, Tangier disease, Type III hyperlipoproteinemia, Werner syndrome, Williams syndrome.[17]

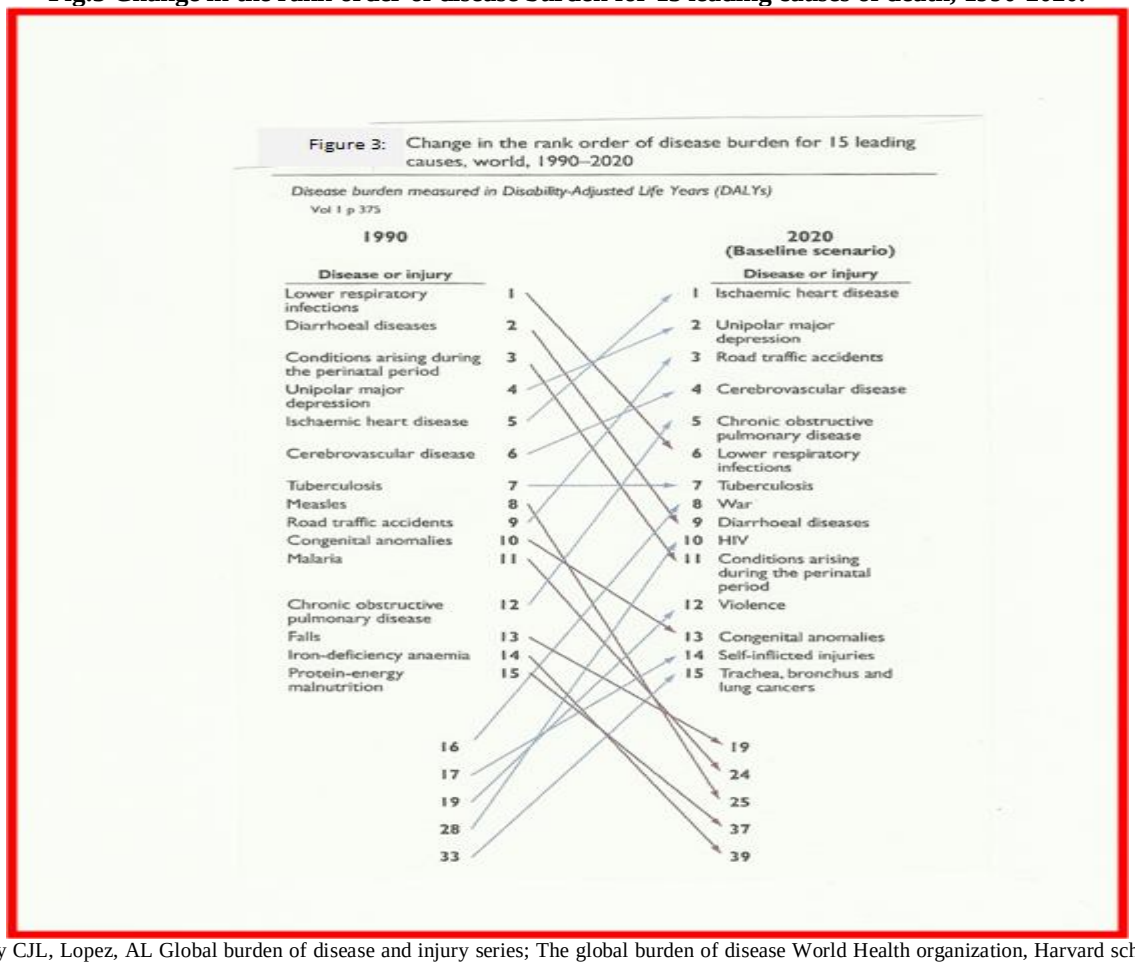
There are health education strategies to prevent many single gene diseases; specifically, hemoglobinopathies, complex diseases, diabetes, cancer, Alzheimer's and other neurodegenerative diseases. Although Gerard, S., Hayes, M., & Rothstein, M. A.[18] recommended "Genomics should be included in every facet of public health; which include infections, disease control, chronic and degenerative diseases, occupational health, and environmental health, in addition to maternal and child health." we must emphasize in the age of genomic science, the need for a comprehensive background in biostatistics, informatics and research methods and health education of the public are necessary. These are the undeniably relevant skills.

The Federal Centers for Disease Control and Prevention (CDC)[19] successfully categorized the ten leading causes of death in United States to include: heart disease, cancer, cerebrovascular disease, chronic lower respiratory disease, accident/unintentional injuries, diabetes, pneumonia,/influenza, Alzheimer's diseases and septicemia. CDC emphasized that nine of these ten diseases have genetic component; therefore ensuring that the new generation of public health professionals become proficient in the use of family history techniques for the primary prevention and early identification of risk factors can be very productive for the prevention and treatment of diseases. Besides, CDC continues to play leadership role in the in the application of family history techniques in various public health initiatives. By Fall of 2004, Dr Richard Carmona,[20] then surgeon –General of the U,S, had encouraged the U.S National Adversary Group at a meeting held in Atlanta Georgia to adopt the week of Thanks Giving as Family History Week, when families congregate to engage in intra-familial networking and celebration. The inclusion of family health status can be very productive by encouraging health professionals who are family members to elicit comprehensive endemic health problems within the family and the treatment modalities that are efficacious with the family, In the developing and the least developing nations, family history techniques as interventional and primary preventive strategies can be integrated into their public health programs to contain cost and nip in the bud, the onset of deadly diseases.

Comprehensive training of public health professionals must prepare them with the skills for developing, validating, family history instruments which could be adapted to the prevailing cultural circumstance of the developing and least developing nations. These family history tools can be used for detecting the risk factors and incipient onset of diabetes, stroke, heart disease, and breast, ovarian, colorectal and prostate cancers. The various family history techniques for preventing cardiovascular disease are now widely documented [21]. To illustrate, health educators must be able to articulate how physicians will be trained to predict whether a patient is likely to develop the incipient stages of diseases such breast, ovarian colorectal and prostate cancer. Health educators will be able to inform patients about ways of making early diagnosis of a disease so as to recommend the necessarily primary preventive strategies. As a component of family history, health educations and other clinicians will be able to use their knowledge of family history to trace diseases that run in the family, predict client's personal risks and mechanisms for preventing such diseases. The demographical data required include, gender, date of birth, age of deceased relatives, etiological agent of the disease the relative died from, consist diet, smoking behavior, possible use of alcohol and other drugs. This knowledge becomes helpful in monitoring such diseases as diabetes, heart disease, arthritis, high blood pressure, stroke mental retardation and other chronic and degenerative diseases.[22].

The US Institute of Medicine [8] published in 2002, "Who will keep the public healthy"? In that report, the non-profit organization itemized the critical areas of public health regarding the training of public health educators in the twenty first century. A synopsis of their recommended courses include**: informatics, genomics, communication, cultural competence, community-based research, global health policy and law and public health ethics**. Based on WHO's predicted disease burden by the year 2020, we must emphasize the need to hone the skills of potential public health professionals in research methods, quantitative epidemiology, and advanced demographic analytical tools to enable public health graduates to have the competence in research design, validate their instruments, collect their data, perform their analysis, and publish and disseminate their findings to the hitherto isolated academic institutions and rural primary health care centers in the developing and the least developing nations. Either at the State health departments or ministry of health, master-prepared public health professionals and those with PhDs ought to be able to assist in integrating genomics into the public health survey instruments with the potential of assisting in the control of endemic chronic and degenerative diseases and disaster management. In the developing and the least developing nations, these public health scientists must be able to assume leadership role in the integration of genomics into the local rural primary health care centers and at the state department of public health. With 34 of the LDN in Sub-Sahara African nations, it is expected that the new generation of public health professionals be trained and competent enough to critically assess the H3African genomic research project. They must use their collective ingenuity to discern the challenges of public health in their nations; detect potential stigmatization/discrimination issues from genomic interventions, challenge biotechnological companies to comply with ethical principles in ensuring their diagnostic reagents have acceptable sensitivity, specificity, and clinical validity and analytical validity of their diagnostic technologies. By validating the quality of their laboratory testing, commercialization of their authentic genetics testing reagents can be disseminated to a broad spectrum of clients worldwide. This will enable a large number of their clients to reap the benefits of genomic medicine.

Fig.3 Change in the rank order of disease burden for 15 leading causes of death, 1990-2020.



Murray CJL, Lopez, AL Global burden of disease and injury series; The global burden of disease World Health organization, Harvard school of public health and World Bank 1996 page4.

Public Health Career employment-seeking strategies

The prospect of seeking employment opportunities and getting employed will depend on the multiple skills acquired as demonstrated by the graduates from public health disciplines. Knowledge about the various institutions and the non-profit and private agencies willing to recruit the highly trained health educators is a major step in securing meaningful and rewarding employment prospects. Besides, very creative public health professionals are able to establish their health-related public health enterprises for the elderly population. Many public health scientists are now known to establish cooling centers for senior citizens at a cost they can afford. Many of these entrepreneurs are now profitably involved in establishing the home-health care business where they cater for the needs of disabled clients and other related clients.

Conclusion

The age of genomic science will continue to challenge the human intellect and the human spirit to become very proactive in our scientific challenges and taking guided risks in harnessing the benefits of genomics to combat hitherto lethal diseases and minimize the impact of numerous single gene diseases which previously led to cognitive and physical handicap and unnecessary mortality and disability.

Acknowledgment

The authors declare that they have no conflicts of interest in this research.

BIBLIOGRAPHY

1 Stanford Encyclopedia of Philosophy The human genome project http://plato.stanford.edu/entries/human-genome/ Retrieved September 30th, 2013
2 Patrinos A The Human Genome Project was more than just sequencing http:// DNAi Cold Spring Harbor retrieved October 9th, 2013
3 WalportM The Wellcome Trust and the Human Genome Project http//genomeWellcomeacuk/docwtx031html retrieved October9th, 2013
4 WHO, *From Alma-Ata to the Year 2000 Reflections at the Midpoint* (Geneva: WHO, 1988): 61. WHO Genomics and World Health; Report of the Advisory Committee on health research Geneva, Switzerland WHO 2002pp1-60
5 Pang T The impact of genomics on global health American Journal of Public Health pp1-4http//www.ncbi.nlm.nih.gov/pmc/articles/PMC1447192/Retrieved September 26, 2013.
6 *Genomics and World Health.*Report of the Advisory Committee on Health Research. Geneva, Switzerland: World Health Organization; 2002.
7 US Institute of Medicine: Committee for the study of the future of public health. The future of public health Washibgton DC National Academy press , 1988pp1-50
8 Lodish H, Berk, A, Krieger M Bretscher, A et al Molecular Biology W.H Freeman and Company2013 pg G.10
9 US Institute of Medicine IOM Who will keep the public healthy? Educating public health professionals for the 21st century." Washington DC National Academy press , 2004pp1-50
10 Dubos, R Human ecology The Jacques Parisot Foundation lecture 1969 -definition of WHO's health WHO chronicles, 1969 23(11) 499-504
11 Green L Definition of health promotion American Journal of Health promotion 1986 pp6-9
12 Winslow, C E.A The evolution and significance of the modern public health campaign New Havens: Yale University Press, 1923 reprinted by the Journal of Public Health Policy vol1 1984.
13 CDC Leading causes of death in United States www.http//cdc.gov Retrieved October 9th, 2013
14 Watson JD Parasitic diseases, public enemy number one Middle East Health., 1978, 2(9) 14-18.
15 Lucas A University Lectures, University of Ibadan, Oyo, Nigeria Unpublished 1977.
16 Murray CJL, Lopez, AL Global burden of disease and injury series; The global burden of disease World Health organization, Harvard school of public health and World Bank 1996 page4
17 CDC list fifteen leading causes of death jan12, 2012 www cdcgov/nchs/data/nchsfactstats/deathhtm Retrieved October9th, 2013.
18 Gerard, S., Hayes, M., & Rothstein, M. A On the edge of tomorrow, fitting genomics into public health policy. Journal of Law, Medicine and Ethics 2002, 30(3) supplement 173-176.
19 CDC ten leading causes of death www .http//cdc.gov/injury/wisqass/leading causeshtml Retrieved October 9, 2013.

20 Carmona R Celebrate family history month-Every month http://www.hhs.gov/family history Retrieved October 9th, 2013.
21 Hunt SC, Gwinn M and Adams TD Family history assessment Strategies for prevention of cardiovascular disease American journal of Preventive Medicine 2003, volume 24(2) pp136-142
22 NIH Consensus Development Program Office of Disease Prevention NIH State of the science conference on family history and Improving health http://consensus.nih.gov/23009/familyhistorystatement.html Retrieved September 20th, 2013

Biographical Notes

E. William Ebomoyi is a professor in the Department of Health Studies, College of Health Sciences, Chicago State University, Chicago Illinois. He holds a post-doctoral certificate in Epidemiological science from the National Institutes of Health, MD, USA and a Ph.D. in community health and statistics from the University of Illinois, Urbana-Champaign, Illinois USA. He serves as a Consultant in International Health for the American Public Health Association (APHA) and he is a pioneer member of the US National Children Study Advisory Committee. He has published extensively in epidemiologic science, genomics, HIV/AIDS pandemics, WHO-sponsored primary health care services programs, and sustainable development. He is the current Chief Editor of The International Journal of Tropical Diseases and Health and Associate Editor of the Journal of Scientific Research and Reports; and the Journal of Applied Global Health