Development and Management of National Health Plans: Health Economics and Statistical Perspectives

Pranab Kumar Sen

Departments of Biostatistics, and Statistics & Operations Research,
University of North Carolina, Chapel Hill,
NC 27599-7420. USA
Preamble

There is an innumerable number of strings, not all ascribable to causal factors nor all working in synergy or reconcilably, which undermine the complex of national health spectrum, its relation to global health, its diversity in the inclusion of people from all walks of life and society, its support by a matching national health economics plan, its impact on human/subhuman QUALITY OF LIFE, and its aim to avert eco-environmental imbalance to disasters. To fathom into this high-dimensional opaque (complex) simplex, there is a genuine need for implementing an interdisciplinary approach wherein health economics, socio-economics and geo-politics are to be properly blended with information and bio-technology, genetics, clinical sciences, epidemiology, environmental health sciences, nutrition and health education, health administration, computer science, and above all, statistical science in its total breadth and diversity in such interdisciplinary setups. Routine use of statistical packages, ultra-modern electronics gadgets and indiscriminate use of modern bio-technology may be totally misleading. It is imperative to comprehend the basic need, the complex foundation in a local, regional, as well as, global perspective, along with the necessity of valid data collection, data monitoring, data quality control and data interpretation (now consolidated under Knowledge Discovery and Data Mining (KDDM) or statistical learning), and above all, a meaningful planning of a serious objective study. The task, though appealing, is challenging, but an accomplishment is genuinely rewarding to people in almost all corners of all societies in our bio-environmentally battered, if not endangered, small world. Let me outline some of the most important factors which need our immediate attention in any objective development study of this complex problem posing a serious threat to the well being of the society, country and mankind. Aftermaths of persistent inequality of income (wealth), education, health care, life style and outlook on life, as we perceive at the present time more profoundly due to fast communication of media all over the world, may wipe out all the so called economic progress and prosperity. There is also the need to incorporate statistical interpretation as well as rationality to many socio-economic to health measures in order to assess the real depth of the problems and the impasses arising thereof. If we do not heed to this urgent task, collapse of a traditional and established social system may be imminent while
ecological imbalance to eventual extinction of life on earth can not be ruled out.

**An Inventory of Points to Ponder:**

1. Poverty - affluence differentials in health care.
2. Health care facilities: Private vs public entities.
3. Affordable and sustainable health care plans.
4. BPL, AAL and no man’s strip: Vanishing middle class.
5. Social security, medicare and health economics.
6. Occidental vs oriental medical practice.
7. Modern life styles and their health aftermaths.
8. Resources: qualitative and quantitative perspectives.
10. Environmental and ecological imbalance.
11. Indigenous resources: cosmopolitan differentials.
12. Inter- and intra-state differentials in health spectrum.
13. National health research centers and their role.
14. Invasion of the Western pharmaceuticals?
15. Export of Indian drugs to the West- a world apart.
18. Malaria - has it been revamped? Drug resistant virus!
22. Infectious diseases and HIV.
23. Disease prevention and cure perspectives.
25. Exposure to narcotics, alcohol and illicit drugs.
26. Quality of life and outlook on life.
27. Coverage of abortion and contraception in plans.
28. Health awareness and attention.
30. Chronic disease and disorders: Their impact.
31. Urban vs rural health care differentials.
32. Malnutrition and health impacts.
33. Obesity, arthritis and gout.
34. Dementia, Alzheimer and Perkinson’s disease.
35. Autism, epilepsy and depression.
36. Industrial hygiene and occupational health.
37. Diabetis and Thallassemia minor.
38. Rationality and feasibility of an universal plan.
39. Epidemiology and demography in strange environments.
40. From mice to human beings - need for animal studies.
41. Need for clinical trials on Indian soil.
42. Academic-government collaboration in health research.
43. Health education and nutrition perspectives.
44. Human development and its impact.
45. Anticipated natural disasters’s health impact.
46. Elderly, especially single people’s plights.
47. Health manageability and governance perspectives.
48. Migrant population from adjacent states (countries).
49. Growth of health related occupation and industry.
50. East is East and West is West, and the Globe in unrest.
51. Impact of paramedical facilities.
52. Objective (statistical) planning.
53. Mega computers to Ipad and cell phones: Can they guarantee quality of statistical appraisals.
54. Data mining perspectives (re: # 53)
55. Wither Statistical interpretability and rationality!

I could continue with the listing of 1001 such items but, to start with, that will only complicate our line of thinking. Statistically speaking or better thinking, it is better to sort out the different items according to their relevance and relative importance, choose (albeit, statistically) a scanty handful (how many?) of the most relevant ones, judge the loss of information due to such a subset selection, minimise this loss statistically, check its sustainability, and develop a manageable (adaptable) plan which should come with the flexibility of progressive (or sequential) amendments and adaptations, as and when needed, once it is operational. Better action than indecision.
Let there be no wastage of time in procrastination,
no illusion of what might befall of our decision.
Let’s not dwindle in our concocted frustration,
let the momentum of action pave the way to perfection.

( Disne samay kaatiye ore samai bichaar kore,
Ki rabe aar ki rabena, ki hobe aar ki hobena, ore hishabi,
a sangsayer majhe ki tui bhaabnaa dolaabi,
paayer bege path kore ne, korish ne aar deri.)

There is a genuine need to incorporate statistical reasoning to fathom out clinical as well as socio-economic undercurrents. Possible amendments may make it more flexible, more adaptable and more comprehensive with the ongoing socio-economic evolution. Inaction or indecision has no place in health economics and health plans. Any health assessment and care study and development of any master plan for that not only needs the active support and intervention of health economics but also a complete inventory of the basic needs, available facilities, burden of our growing human family, and the vast inequality affecting the affordability and sustainability of any health plan. Fradulant use of superficial universal health care plans in one hand and lack of affordibility on the other hand can create impasses. Funding support from employer, government and other sources may be a stumbling roadblock to an effective plan. A recent news release (NYT: November 20, 2010) raises some other concerns too: India needs quantum steps in investment: Microcredit is imperiled in India by defaults. Industry, accused of profiting from poor microfinance, could become Indian version of (US) sub-prime mortgage debacle in which the noble idea of extending homeownership to low-income households threatened to collapse the global banking system because of a reckless ‘grow at-any-cost’ strategy. It has deep implication on development and management of any comprehensive health plan. Each of the items mentioned above may have serious impact on any master plan and the tailoring needs to be done in a balanced way so as not to affect abruptly or eliminate any major sector of the population. Borrowing blue-prints of health plans and their management schemes from the occidental countries may be disastrous for the oriental ones. The poor are poor and the rich are rich in all societies and countries, yet their plight is different in its individual way across the global spectrum. Affluence has
darker face of the moon too while poverty, inspite of having a better or sober outlook on life in an oriental tradition, may virtually wipe out the social equilibriu if the poor-rich inequality persists not only in monetary / attitude towards life sense but also in sheer numbers in each sector. There are the so called social unrestability alpha-factors that can be deleterious for human societies. There are some paradoxes on conventional economic measures and interpretations that needs to be thoroughly appraised in an objective manner. Perhaps, the African picture can convince us to blend the global perspectives with specific regionals. For over two decades the world has witnessed a phenomenal growth of manufacturing industry and gross economic growth in the Mainland China. China has secured the fastest computer, fastest bullet-train and biggest hydroelectric project too. It may be tempting for India to follow the Chinese avenue of economic reforms; both the countries have population exceeding 1.30 billion with a vast majority of rural and poverty-striken people. China claims to have lot of prosperity across its socio-economic sectors, as well as, in the international trade spectrum; it is controlling the global economic flow. It has accumulated a huge reserve of foreign exchange and it has the largest export to the West as well as Far East. Even China is using its negotiable currency for trade transaction with some third world countries. Critics of China have pointed out some contrasting features of this spectacular economic growth of China in relation to its human health and human rights. In a nut-shell, the industrial evolution in China, exploiting the cheap labour under strict state-control economy, has achieved spectacular economic strength. However, the China sky is increasingly embracing the undesirable super-pollution status, far beyond the accepted norms for developed countries. The China population is tilting more toward the industrial pockets, whereby the rural areas are being neglected. The economic disparity of urban and rural sectors is unbearably massive. In short, more prosperity means greater distributional disparity and greater environmental health concerns leading to more escalating health care disparities. Can China avoid some of the problems India has encountered during its post-independence era, particularly with labour and labour unions? Can the Shanghai slums be forced out of sight by the glamouring economic developments in their waterfront-towers? Can the violation of human rights be suppressed by the massive economic control the State has? In all these respects, there is a gulf of difference between India and China. Can Hong
Kong retain its economic development, financial prosperity, skilled industrial accomplishments and affluent life-style under the unpreventible pressure from the Mainland? In the former CCCP (Soviet Union), under strict state control over all matters, inspite of spectacular advances in academics, space exploration and military development, the lack of human rights and freedom of expression ultimately paved the way for the breakup of the gigantic union and diminished its international dominance as a controlling power. Can this be predicted for the Mainland China as well? Can we project the China picture on India? How is their health care system shaping up in either China or India in the midst of this turmoil?

Coming back to the shanties in India, do we have a homogeneous pattern in all of its states and regions? Can the Gobraa-Tangraa-Koshba slum dwellers in Kolkata dream of a hospital bed in need, not to speak of other modern surgeries and medical amenities which only the affluent can afford to have? Even if we look into the basics of their perineal plights for survival, we may notice that they may have no clean water for drinking or other necessary daily uses, no power (electricity) in most cases, no toilets of any reasonable standard, garbage disposed along the roadsides along with the men, women and children defecation, invaded by street dogs and rats and littered around everywhere. Many of these slum dwellers, mostly women, who work as fixed-time domestic servants in the high-rise apartments, not far from their slums, use some make-up toilets for them at their ground floor; the apartment aristocrats pretend that those toilets are hygienic, without realising that they could be the most common causes of contamination of many GI and abdominal diseases and disorders for them too.

For the other people in the slums, or even for the domestic workers in the odd hours, they defecate just by the side of their shanties on the roadside, pretending that it would go unnoticed by others and the mess left behind would not interfere with the environment that is crippling not only them but also the privileged people whom they serve. How the picture compares with the Mumbai bastees? The Mumbai slum of Rafiq Nagar has no clean water, no garbage pickup and no power except from halfhazard cables strung overhead illegally; *Not a single private toilet or latrine for its 1,000 people!* (AP, Oct. 30, 2010). Yet nearly every destitute family has a cell phone; some have three. By this time, there are more than 700 million cell phone connections in India, while UN estimate is that about
366 million Indians have access to a private toilet or latrine, leaving nearly 700 million to defecate in the open. In the slums of Mumbai, home to more than half of the City’s 14 million population, the yearning for toilets is so great that enterprising residents have built makeshift outhouses on their own. Alas, they dispose the waste into a river of sewage that children splash in and adults wade across. Also, the paid toilets cared by the municipalities, are not properly supervised, not all in working conditions, and not affordable by the destitutes. The picture is no better in other metropolitan areas. While India can boast of its growth rate of 8.5 percent a year (Govt. figure), among the highest in the world, only a fraction of the over one billion population have benefitted from India’s economic rise, more than 90 percent remain mired in some of the worst poverty in the world. India has some of the worst child mortality and maternal death rates outside the sub-Saharan Africa. This disastrous feature is not due to the shanties alone - it has permeated in the middle-class population too; even the affluents are not immune to this catastrophe. Are the public hospitals running in proper environment and in adequate facility to meet the real need of poor people. Even the retired and elderly people may have the same plight for their much more needed health care facilities. Can these people afford to have the nursing homes for better health care facility? An affluent class tale: are we having unnecessary and expensive prescription drugs and surgical treatments when some socio-medical counselling can serve the purpose equally well? How the health care system can handle this delicate problem? A poor class tale: Can we afford to have any effective medical treatment within our means? A sandwich tale: A part of the middle class society is shrinking below the poverty line (BPL), no matter how we define and interpret the BPL, and the complementary part aspires to cross the affluence line at any cost to their social life, tradition and integrity. What universal health plans mean in such sandwich socio-economic setups? The interface of modern India has a glamouring side in electronics, information- and nano-technology while the darker face of moon rests in total desolation, as if the outcasts of our society. This class of socially and economically untouchables, in-admissibles and unreachables may pose the greatest threat to any social system, including welfare and health care. Should we leave out specific sectors of a society in adopting a health plan? Can we ignore the possibility of a drastic breakdown of all social facilities and provisions if a greater part of the society is left out?
Can we then proudly display our heritage: "'Ayi Bhaarater mahaamaanaber saagartire"? Alas, if we look back from the ocean-front of our concocted image, albeit our presumably short vision will be blocked by the glamouring skyscrapers and dazzling commercial billboards, a little more penetrating look into the deep hinterlands of our growing human family will reveal a drastically different and yet true picture: A contrast of landscape with perturbing shanties fruitlessly fighting back to arrest the slaughtering march of the water-frontliners from engulfing them in brutal strength of monetary affluence and political muscles. (Raajaar hasta kore samastha kaangaaler dhan churi; the affluents, being the surrogates of the modern monarchs, are all out for the rampage on the destitutes.) We forget that the lack of sanitation at the shanties is contaminating the prosperity of the frontliners by the very service they immensely receive from the shanties.

Oh my unfortunate, whom you have dejected in disrespect, 
deprived of all social justice, equality, to fall apart:
You are destined to share with them the same fate, 
unless you adore them back being equally affectionate.

" He more durbhaga desh, jaahaader korecho apamaan, 
apamaane hote hobe taahaader sabaar samaan.
Sanmuke daaraye rekhe, kole jaare dao ni sthaan, 
apomaane hote habe taahaader sabaar samaan."

The middle-income sector, especially in India during the British-Raj era, produced the elite of intellignencia and were highly visible in all walks of society and civil adminstration. Thanks to the impact of information technology, part of this middle income group got a chance to move above the affluence line. This enabled India to move out of the poor income status to the middle-income status. At the sametime, a larger part of the middle income group shrunken below the poverty line, thus increasing the proportion of the poor people. Recently, this feature has been pointed out by the United Kingdom based economist Andy Sumner who lamented over the increased number of poor people. There is a statistical paradox, however, and we will discuss that briefly later on. Just by the number
of poor people, we can not assess the depth of poverty.

There is a saying that 'charity begins at home'. Can we start with a small model scale in our home state and incorporate this pilot study in a better venture for the country and society as a whole? What the South India is achieving why is that not possible in the Eastern zone? Is it a nation disintegrated at the very basic regional and social level? It took considerable efforts on the part of governments in the West (Europe and North America) to formulate some social security or social welfare plans in the mass scale to embrace all reaches of the society and to provide medicare benefits for the elderly. Yet some of them are far from being ideal in coverage or administration. Even in USA, it took a long time to institute a universal health insurance plan and even so, the present one is highly opposed by a sector of the society and the coverage is less than three-quarter of the population.

**BPL, AAL, NMS and nested inequalities.**

From time immemorial, inequality in all walks of life and society has been an acceptable phenomenon, be it at the level of caste, creed, religion, income or wealth, and hundreds of other factors. If you allow such multifactor interference, inequality simply becomes so overwhelming that it can impede the progress or even the existence of a rational society. Most of these inequalities have been man made and they have evolved in various modules at various times and in different countries too. The compartmentation of any society based on these factors inducing inequalities of diverse types may invariably result in differential life style and predominant standard of living patterns. Therefore, any development of health plans must take into account this intrinsic heterogeneity of human health and life, and should address the problem adequately.

India has never been looked upon as an integrated nation, nor even today, though politically it may be marshalled in that way. Leaving aside the inter-caste, inter-creed as well as, inter-faith diversity which persists, albeit may not be to an unmanageable extent, in every corner of this self-claimed single nation, there is considerable difference in the outlook on life, standard of living and many other ascribable factors. The riot of emotion and community level interaction may be
at dispersion across the regional fractions and so is the level of corruption. The neighbouring countries Bangladesh, Pakistan, Nepal, Myanmar or Sri Lanka are no better in this respect. Ethnicity dominates social spectrum, and even intra-ethnic inequality may be highly perceptible. Health picture and need for health care may vary drastically across these small pockets created by not only ethnicity diversity but also within group inequality in living condition, life-style and outlook on life.

Traditionally, in India it used to be difficult to characterise the poor or rich people simply by their possession of wealth or property. However, during the pre-independence era, caste, creed and ethnicity disparities started revolving around another interpretation: poor, middle class, and rich in the yardstick of standard of living, and this in turn, started revolving around some manageable interpretation of wealth or real income. The classification of poor resulted in a fixation of a, so called, POVERTY LINE. Similarly, the concept of AFFLUENCE LINE took its place in economics, leaving in between the two lines a significant sector: MIDDLE INCOME CLASS, which may not feel comfortable in morality or dignity to be classified as poor and at the same time may not afford to match the life style of their neighbours, the rich or affluent people. No wonder, sooner or later, the middle income class bifurcated into upper and lower middle class, in their differential objectives of life-style or standard of living. Even so, the fundamental qualm remains in tact: How to combat the brutal force of nature and geo-politics regarding threats to the tailored 'matsa maariba khaiba sukhee' life-style and thereby accelerating unpreventable, unpredictable health problems. It became clear that the need for health plans is genuine across these small pockets of ethnicity and at the same time, the plans must be flexible enough to suit this diverse scatter of our growing human family. There may not be a need to import coal to New Castle, however, there may be a tremendous shortage of basic products in India when they are exclusively destined for export.

Basically, either based on individual income or family income and some a priori consideration of a minimum standard of living, a poverty line used to be defined as the dividing income line. Such a below poverty line (BPL) would discriminate the poor from the not-poor class. Similarly, based on some detailed considerations, an affluence line or level of real income classifies the rich people in being above the affluence line (AAL), and those who were neither in the BPL or AAL sector
would constitute the middle income group - a no man’s strip (NMS) in the income distribution of the entire population. Leaving aside the rationality of drawing a poverty line solely based on some sort of income distribution, there is a pertinent question: Can we treat all the poor people alike? They differ as much as in their income as other physical as well as mental traits. As such, such hidden factors need to be taken into account in prescribing a meaningful interpretation of the BPL. I am a little bit surprised that keeping in mind the per diem protein intake, a surrogate variable, namely, per diem calorie intake is sometimes used to determine the BPL. Can the proportion of the calorie due to protein intake be assessed fairly by looking at the total calorie intake? Can we treat the animal protein and vegetable protein in the same way? Can we ignore the vast number of explanatory variables or covariables in this assessment? What could be a reasonable statistical equation in a comprehensive modeling of BPL? Are we not to integrate health awareness, outlook on life, level of education etc. in the formulation of BPL? How are we to differentiate between various sectors in interpreting the BPL? What about the role of income gap ratio and Gini’s coefficient? Assuming that it is feasible in a political world to have a Robin Hood-economics shifting the wealth to a certain extent from the affluent class and redistributing it to the BPL class, will it be better to do that in a uniform way under the BPL or to have a specific way to improve the poverty index without changing the number of poors? For example, if we put more relief to the people just below the BPL and much less to the people in the other end of the spectrum, some of the borderline people will cross the BPL though the income gap ratio may not be less. By virtue of smaller number of poors, the resulting poverty index may be smaller too. On the other hand, putting more mass at the lower end of the spectrum might make the BPL people relatively more homogeneous and thereby reduce the Gini coefficient and may reduce the poverty index. From social welfare point of view which will be more rational. Further, the present socio-economic dynamics have been steadily moving the affluence index upwards by tilting the affluent income distribution to the right. Perhaps, there is a genuine need for statistical science to provide valid, interpretable and efficient resolutions, not just how to lie with statistics. In a subcontinent like India with diverse climatic factors and with the growth of urbanisation, it is bound to have natural calamities as well as aftermaths of industrial catastrophies - they affect the victimised people along with others who
indirectly depend on these likely victims. The Bhoopal chemical toxic gas exposure back in 1984 is still having impact both economically and healthwise on a significant sector. Naturally, it may be better to have some provision for such possibilities in safe-guarding the health economics and maintaining the provisions of an adequate health plan.

Clinical Perspectives:

Let me start with the clinical aspects which relate to the foundation of any comprehensive and composite health assessment and health care plan. It may sound rather offensive, especially in India, if I say that the evolution of medical science has been mainly governed by the empirics, to a lesser extent by the heuristics, and only in the recent past and to a very limited extent by the stochastics. Medical science has never been regarded as a bonafide member of the Exact Science Club, albeit the surgeons may vehemently scold: in what way surgery is less a technology than other coveted science disciplines covered under the omnibus umbrella of technology? The Satu Baddi’r Rognaamchaa may depict a nice picture of the evolution of medical discipline clearly illustrating the development of the clinical side based on the empirical traditions of the amature barefoot doctors all over the world. Yet, can we deny the vast amount of intuition that needs to be exercised by a surgeon before deciding on any specific case: whether or not to go for surgery against other medication options? Can we also deny that no two human being having similar symptoms of a medical problem would be identical with respect to the nature and degree of the problem, nor would require exactly the same treatment? It is this immense variability of human beings with respect to their metabolism, response to drugs and treatments, as well as, exposures to various health hazards that makes medical sciences more experimental in flavour, less precise in an action-reaction mode, and more difficult to administer for therapeutic and diagnostic uses. Indeed there are various challenges in medical sciences, and it seems that we are nowhere near the end of the tunnel. At this juncture of time, medical sciences have been embracing a wider interdisciplinary field where clinical sciences and information technology (IT) have captured major attention from every corner of the globe and all walks of life. Yet, inspite of all our advancements in science and technology, major challenges
have erupted from improper and careless treatment of our bioenvironment. This has indeed a serious impact on our public health, especially in the developing countries where resources inequality may create roadblocks to take the much needed remedial actions. Our bioenvironment constitutes the totality of entities of all socio-economic, cultural-political, clinical, biomedical, ecological and environmental (health and hazards) perspectives that are relevant to the existence as well as propagation of all biosystems on earth, including mankind. The concept of Quality of Life (QOL) having its genesis in medical communities for reporting the status of patients undergoing some treatment for a chronic disease or disorder has emerged as an essential tool for the assessment of the diverse impact of environmental hazards; we are only to blame ourselves for such catastrophic bioenvironmental impacts on our life and ecosystem. The eco-environment of our mother planet is indeed endangered with life-threatening phenomena, not only due to escalating ecological imbalances and environmental disasters, but also due to mounting social, economic, religious, geo-political and cultural disruptions. While we are combating with existing major health threats (like cancer, tuberculosis, gastro-intestinal diseases, cardiovascular and coronary blockage and strokes), new or hitherto unknown forms of catastrophic diseases or disorders (such as the HIV/AIDS) have invaded our life and posed enormous risk to our health and survival. Bioenvironmental toxicity of various forms and kinds has attained an alarming level, and unless abated to a needed extent it would shower us with all sorts of bioenvironmental disasters. Even mental health aspects deserve a close scrutiny in the light of bioenvironmental impacts.

Assessment of health-hazards from bioenvironmental toxics with a view to implementing (physical as well as mental) health promotion and disease prevention has been one of the major tasks of the public health discipline. However, realizing the far greater impact of our fast-deteriorating bioenvironment, public health has become an interdisciplinary task where environmental health sciences and public health disciplines (including epidemiology, maternal and child health, nutrition, among others) have combined forces towards a better understanding of the underlying complexities and better assessment of the risk. In the West, government regulatory agencies as well as non-government pharmaceutical research groups have also joined this task-force. The situation may be quite different in developing countries; even data-collection in a very objective fashion could be a
problem. (Bio-)statistical reasoning is essential in this respect. Statistical planning, modeling and analysis play a fundamental role in this context. We shall mainly stress here the statistical perspectives in this setup, and discuss suitable resolutions viewed from a wider perspective of consolidation of bioenvironmental health and public health disciplines.

Empirics and Heuristics.

Countless generations of human beings, especially in the Orient, have survived on herbal medicine, with very little surgery. The treatise in *Ayurveda* provides an excellent account of human acquisition of the knowledge of medicinal values of various herbs and plants. Be it an act of God (like the whole Veda!) or not, over thousand of years, more precise use of herbs and plants laid down the foundation of medicine and therapeutics. Even the medical system in the West owes a lot to the oriental herbal medicine. The darker side is the fact that some disorders, like Diabetics, were identified over thousands of years ago (Madhumeho to Bahumutra), and dietary restrictions along with herbal treatment were in effect even at a village level. Yet, in modern India, though Diabetics is the number one disease, we have neither mastered the ancient herbal treatment to make it more affective and more usable with our living style nor updated the potential use of such herbal in rigid Western medical plans. The vast knowledge of India’s herbal plant has been exported to the West while more and more India is relying on the Western pharmaceuticals to provide the needed drugs not only at a huge cost but also in doses possibly inappropriate for the Indian subcontinent. Empirics and heuristics are very important to guide us through this dilemma and lead us to a sustainable and affordable plan to combat such disease and disorders. The genetic factors which India adopted longtime ago in maintaining the social caste system can provide a wealth of information on the genetic effect in such chronic disorders and diseases. The diet is different from the West, our features and hereditary factors are also different from the West, so are the climatic factors. Empirics and heuristics should be an integral part in our drug-discovery and criminal practice. Jumping on the occidental train for a better ride could be bumpy.
Fruits of Environmental Toxicity.

Environmental toxicity (ET), emerging mainly through environmental pollutions and contaminations, has posed serious threats to the safe and prosperous propagation of mankind. The picture is highly complex due to multiple interacting sources of pollutions and contaminations, and virtually no country ranging from the poorest one to the most industrialized one is immune from these disastrous environmental toxicity effects that have surpassed the traditional biochemical level of penetration well into xenobiotics. We are susceptible to xenobiotic environmental toxicity effects through a combination of absorption, inhalation and ingestion, though it may be argued that inhalation may be the primary industrial/occupational/environmental site of uptake of toxins. The water we drink may be contaminated with chemical dumpings, the food we intake may have serious contaminations from pesticides, and above all, the air we inhale may contain significant amount of airborne particulate matters (APM), chemical (industrial) wastes and exhausts, automobile exhausts, gaseous emissions from garbage disposals and land-fill sites, environmental smoking effects, local or environmental tobacco smoking effects (both active and passive modes), thinning of the ozone layer (greenhouse effect), and an innumerable number of other factors, likely to cause toxicity of certain types. The intensity of ET has gone up dramatically in the past two or three decades, and awareness of this serious risk is a must for our survival. In fact, assessment of this risk with a view to minimise it to the extent possible is by far one of our most challenging scientific tasks. An interdisciplinary approach with due emphasis on statistical reasoning is essential for this endeavor. Sen and Margolin (1995) and Sen (2001) have addressed the toxicological issues with due emphasis on the statistical perspectives. We may refer also to Sen (2000 a, b, c) for some critical appraisals. Basically the different modes of toxicity intakes by human being are interrelated, and there is a need to have a more comprehensive statistical modeling that takes care of their synergisms as well as specificity to a desirable extent.
Despite the presence of some plants that can live on air, sunlight, and moisture, most animals require all three essential resources, namely, air, water, and some form of food intake for survival. The human respiratory system takes in oxygen-rich air, which is then transported to the alveoli where inhaled oxygen is exchanged for carbon dioxide and water vapor. As inhaled air contains some potentially harmful components, there can be a gradual blockage of the exchange of oxygen and impure gases at the alveoli, leading to toxicity at the blood level. Tobacco and other narcotic elements can trigger this toxicity process, and are believed to be a primary cause of cancer and other respiratory diseases. Reduced oxygen to the cortex area can result in brain malfunction and mental health issues. Automobile and industrial exhausts contribute to the quality of air, leading to diseases and disorders. Our modern lifestyles, with increased dependence on chemical and aerosol products, deforestation, and uncontrolled energy consumption, have led to the thinning of the ozone layer and the greenhouse effect. Increased ultra-violet levels due to sunlight are a significant cause of absorption toxicology, leading to skin cancer and other epidermal diseases. The elimination of lead from gasoline has improved air quality, though there is much more to learn about xenobiotic effects. The burning of oil facilities in Kuwait twenty years ago caused a significant ecological disaster, whose effects are still evident in affected populations. The Iraq-Afghanistan conflict over the past nine years and still uncontrolled has led to environmental and ecological disasters. In the Vietnam War, the use of chemical warfare had a similar impact. Emissions of radioactive fumes from nuclear power plants as well as chemical toxic fumes from other industrial plants (Bhopal, India 1984) have a catastrophic impact on air quality. Public health and environmental health scientists have brought to the attention of governments, regulatory agencies, and the public that such toxicities have severe impacts on human behavior and fertility. The study of

**Quality of Air: Inhalation and Absorption Toxicology.**

Although some plants live on air, sunlight, and moisture, most animals require all three vital resources, namely, air, water, and some form of food intake for their survival. The human respiratory system inhales oxygen-rich air, and at the alveoli inhaled oxygen is passed on to the minute blood vessels while carbon dioxide and water vapor are exhaled out through the mouth. As and when the inhaled air contains the APM some of which are toxic, there may be a gradual blockage of the exchange of oxygen and impure gas at the alveoli, resulting in toxicity at the blood level. Tobacco and other narcotic elements can trigger this toxicity process, and is supposed to be a principal conveyer of cancer and other lung diseases. Reduced oxygen to the cortex area also induces some malfunctioning of the brain as well as the central nervous system, and as a result, physical as well as mental health problems may crop up. Automobile and industrial exhausts add more undesirable elements to the surrounding air and they also lead to various diseases and disorders. In a different mode, our modern life-styles, increasing dependence on chemical and aerosol products, deforestation, and uncontrolled energy consumption have all contributed to the thinning of the ozone layer; in turn, we are having the so-called greenhouse effect. The increased ultra-violet level in the air through sunlight is a significant cause of absorption toxicology, and skin cancer as well as other epidermal diseases are associated with this effect. The elimination of lead from gasoline products has resulted in some improvement in the quality of air, though there remains much to ponder into the xenobiotic effects of ET. Burning of oil facilities in Kuwait twenty years ago resulted in an enormous ecological disaster, and some of the effects are still perceptible in affected populations. The Iraq-Afghanistan episode during the past nine years and still not under control is a vivid picture of environmental and ecological disasters. In the Vietnam War, the use of chemical warfare had a similar impact. Emissions of radioactive fumes from nuclear power plants as well as chemical toxic fumes from other industrial plants (Bhopal, India 1984) have a catastrophic impact on air quality. The efforts of public health and environmental health scientists, it has come to the attention of governments, regulatory agencies, and the public as a whole that such toxicities have severe impact on human behavior as well as fertility; the branch of
neurotoxicity and reproductive toxicology deal respectively with these aspects. All of these have dominant genotoxic undercurrents, and the modern developments in molecular biology and genetics are casting light on such perspectives. And yet, not much is known about this complex ET phenomenon. Let me quote a small piece of my own imperfect perception of Tagore’s ”Mana more megher sangi ure chale dig diganter pane,” in this context of ET in a global perspective (Sen, 1993).

Monsoon in the Acid Tune

No matter whether in Yokohama, Singapore, Mumbai or Toulouse, the monsoon is the echo of expectation of the human swallows. Let the peacock in thy heart dance with the tune of monsoon, and thy emotion in a chariot of rainbows be in full bloom. Let the rivers flood their thirsty banks in sheer generosity, and the golden harvest echo hearty thanks to the Almighty. Let the fragrant clouds convey thy spontaneous greetings, can there be any one blind to the awakening of surroundings? But, in our era of immensurable atmospheric pollution, can monsoon bestow you with any spiritual resolution? With the seeded clouds, where are the exclamations? It’s down to earth invasion by lots of dissolutions. Rain drops are soaked with sulphur, acids and monocarbons, streets flooded with human waste, as well as, garbage in tons. Normal living utterly disrupted by the dreadful diseases, from eyes to lungs to the intestine, the aging processes. A drop of monsoon kisses the lips with an utter bitter lemon, and in this shower, you feel as if a rape by an orge demon. Monsoon in the acid tune, the harbinger of pollution-tycoons, but, alas, whom to blame for our own industrial festoons?

Food, Drink and Drug: Ingestion Toxicity.

Massive use of fertilizers and pesticides have indeed increased the food grain production and storage preservation capabilities. Yet, a significant percentage of
argicultural products gets unusable due to poor distribution from the original sources to the markets, and more significantly at the cold-storage facilities, often used for price hiking and manipulations. The present “Onion Crisis” in India is a typical illustration of this unscrupulous hoarding business. At the present, in the West, genetic technology is incorporated in achieving further revolution in food production and distribution. On the darker side of the moon, there are some concerns which are coming to the surface at an increasing rate. Carcinogenic activities of the food preservatives and pest control products are being detected in an alarming note. The human consumption of red meat is raising question about the health effect of fat and elevation of blood-level cholesterol that are in abundance in such products. The battery of cardiovascular and coronary diseases has found their link to consumption of high-fat high-cholesterol food items; even the fried foods are being classified as high-risk. "Jaoo thaakur chaitana chutki niya, eso murgi haate Kalimuddy miaa." In the drink sector, even the so-called soft-drinks are also collecting report cards on their health effects. Alcoholic drinks not only affect the central nervous system and destroys thousands of cells in the cortex but also induce intoxication that could indirectly lead to devastating effects. "Bole falo tomar wish ki, aek chataak jalee tin chataak whisky". In the West, death and disability from automobile accidents on road is a significant cause of human casualty, and no wonder a majority of these are actively or passively due to drunk driving. Drugs are even more notorious; drugs should not be classified in the same category as medicines. Narcotic drugs and illicit drinks have been stamped as an alarming international threat. Even on the medicinal front, many of the prescribed drugs are known to have some (and often serious) side-effects. The use of contraceptives has become so widespread that it is unthinkable how for thousands of years human society survived without such devices. The escalating incidence rate for breast and uterus cancer for women can be accounted to a greater extent as linked to such practice. On the other hand, there is a natural need for estrogen intake for women at a certain stage of their life, and yet we can not rule out carcinogenic side-effects from such use. Faced with our task to control the growth of human population on earth, the basic dilemma is whether or not to go for population control? It’s a strange bioenvironment. During the past 55 years, we have literally surrendered ourselves to antibiotics; they used to work wonder and sometimes as miracle against some diseases that were once
thought to be incurable! But, after 50 years, we see the fruits of our blind faith in antibiotics; their potency is decreasing at an exponential rate, and microbes that are antibiotic-resistant are coming back at an alarming rate. We claimed some twenty years ago that malaria has been eliminated from earth (as the DDT and other products were indiscriminantly used for eradication). But during the past few years Malaria is back more virulently than before. It is not out of the way to mention here about the HIV/AIDS problem that is so widely prevalent at the present time, and drug and abnormal sexual practice related that unless abated it could completely reshape our bioenvironment with far reaching and deleterious effects.

**The Water crisis: The Fountain of Our Life.**

Water is indispensable for human life on earth. For biological and physiological needs, we need to drink a lot of water, and we need to use water for cooking and sanitation purposes. Water is needed for our agricultural as well as industrial needs, and it is needed for any other task in life. And yet, in this desperate need, we have ignored the basic alarms: what quality of water can we expect with all our misuse, especially for our growing human family? Basic problems with the maintenance of viable quality of water are the following:

(i) Water contamination due to industrial as well as human waste dumping in the waterways (rivers, lakes and even seas),

(ii) increasing deforestation resulting in more soil erosion not only at the origin of rivers but also in sediment deposition all along their way, having high level of bacterial and other arsenic contents,

(iii) inadequate handling of recycling of water for urban needs (the sewage problem),

(iv) natural disasters like flood, hurricane, tornado which sweep away all toxic (decomposed) ground substances to waterlines, and on top of that, quite often have dead animals and open sewage in the water streams contributing an enormous ecological problem,
(v) industrial (subsoil) dumpings that leads to highly toxic materials which find their way to water channels, and disrupts marine biology (killing of fishes etc),

(vi) deep tube-well and arsenic sussoil material (rehabilitation areas), and

(vii) oil spills in coastal waterways that also affect marine biology, and thereby contribute to the water problem. In port-cities like Cittagong or Karachi, for example, the drydocks for painting the outer hull of boats and other maintenance facilities result in dumping of toxic and arsenic materials in the river mouth, and with high and low tides they are often carried for miles in the upstream inlets. The climatic changes all over the world (including the greenhouse effect) are also contributing to the deterioration of water quality. Increasing demand for water consumption from urban and metropolitan areas and subsoil ground arsenic contents of some areas also contribute to this crisis. Even in technologically advanced countries, the water crisis is not uncommon. Contaminated water (with arsenic as a significant factor) is a tremendous threat to human being and can cause all sorts of health problems.

Quality of Life: Quantification and Assessment

It is indeed a composite task to define quantitatively the quality of life (QOL) in the context of bioenvironmental impacts and public health concerns. Much of this assessment relates to a quantification of some qualitative states in a form that would permit statistical interpretation, modeling and analysis in a simple and yet valid manner. To a socio-economist, QOL would be more appropriately interpretable in terms of standard of living, and in that way, there is a natural emphasis on affluence, poverty and income inequalities. Nevertheless, the quantification of real income or wealth is itself a very delicate task: converting the life-style and social environment of people from different walks of life into comparable income is often highly controversial, and the top economists are still struggling to tune it in a mutually agreeable norm. In the present context, the situation is even more complex. Our bioenvironment of course relates to standard of living, and much of the damages made to our bioenvironment relate to an at-
tempt to maintain the standard of living with modern facilities. But then we need to assess how this has created health related (HR) QOL problems that governments and the public are becoming aware and increasingly concerned from health policy and administrative points of view. In the present study, we therefore pay more attention to HRQOL. In this respect also biostatistics plays a fundamental role, albeit it needs to be tuned with health management and health policy, epidemiology and of course, environmental health sciences.

**Statistics: Perspectives and Task Ahead**

Statistical reasoning is essential in the assessment of the bioenvironmental state of earth and the consequential health risks for human being. In addition to bioenvironmental factors that can be easily identified and quantitatively assessed properly, there are others that are less apparent and or may have relatively more qualitative flavour. Moreover, literally there are scores of such bioenvironmental factors and it needs to be settled how all or some of these are relevant to a specific study relating to specific health effects. Keeping these in mind, we may categorize the main role of statistical reasoning in quantitative risk assessments of bioenvironmental hazards into five sectors:

1. Inventory of sources of toxicity and quantification of intensity of specific items.
2. Acquisition of scientific evidence of dose-response relations through laboratory (dosimetric) studies mostly involving subhuman primates.
3. Collection of information on human experience through epidemiologic (observational) studies.
4. Data collection, data-quality control and statistical monitoring of dosimetric or observational studies.
5. Pooling of statistical evidence from acquired datasets in dosimetric and observational studies (Meta analysis).

We have a flow-chart of bioenvironmental effects:
1. Pollutants and Toxicants: Environmental Sources

2. Human Uptake

Absorption  Ingestion  Inhalation

3. Aftermath
Physiological, Toxicologic and Genetic Undercurrents

4. Environmental Diseases, Disorders and Health

The basic goals are (I) Relate (1) to (4) with a view to control and improve the impact of bioenvironment on human health, and (II) Identify the deleterious sources so as to minimize the impacts in (4). But the basic question is can we ignore (2) and (3) in this quest? Also, to what extent can we have experiments with human subjects? Further, what are the complications in such studies? The discipline of epidemiology has a great bearing in this respect. Epidemiology aims to combine information acquired from etiologic, toxicologic as well as observational studies. In order to be able so statistical reasoning is essential in the planning of such a study, in developing statistical models that take into account epidemiologic undercurrents fully, and to draw statistical conclusions in an objective manner. As in most of other clinical and biomedical studies, risk analysis can only be made from experimentation (e.g., clinical trials, laboratory experiments, tissue culture etc.,) or observational data set, in either case, under well defined objective plans.
that permit statistical conclusions to be drawn in a valid and efficient manner. In this respect there are various points of difference between laboratory experiments and bioenvironmental studies. First and foremost, whereas a conventional experiment can usually be conducted under generally controlled setups, in bioenvironmental studies there is much less of a control in setups. In this perspective, the design of bioenvironmental studies may be quite different from conventional agricultural or biometric studies. Parallel to the idea of blocks and plots in agricultural experiments, here blocks could be designated areas in case of air pollution or water contamination studies, or specific sectors of population in case of specific disease studies. The plots could be subsections of such blocks or even individual persons. In any case, the conventional assumption of plots within a block being statistically equivalent may not be tenable in bioenvironmental studies. In fact, the units in a bioenvironmental study may have a number of auxiliary or explanatory variables in addition to the primary response variable(s), and they usually have profound effects on the response pattern. Therefore in statistical modeling, these explanatory variables need to be incorporated in a suitable way; this introduces complications in the design and modeling of bioenvironmental studies. Secondly, in standard statistical models, it is often assumed that apart from the systematic component the response variables have chance components or errors that are independent and identically distributed. This stringent assumption is most likely to be untenable in bioenvironmental studies, As a matter of fact the very process in which data are collected can induce considerable complications in the sampling design and associate statistical models. For example, in air pollution studies, suppose one wants to record the level of carbon monoxide and other pollutants. This might depend very much on the proximity of the site to emitting sources; it could be also different at different time-points and different altitude from the ground level. Further, the question of practicality of recording such observations remains open. It’s quite different from measuring rainfall at a place! Therefore, the intricate structure of sampling design has a great bearing on statistical modeling, and monitoring of data quality is an essential task. There is also a visible spatio-temporal variation structure in most bioenvironmental studies. In conventional studies, it is generally assumed that there is a homogeneity with respect to spatial dependence, and often, the kriging methodology involving variogram models yields manageable statistical resolutions. However, in the ab-
sence of such a spatial homogeneity, the kriging method may lose its appeal to a greater extent. Moreover, the conventional linear models may not be tenable in bioenvironmental studies (as often the response variables are count variables with distinctly skew distribution and nonlinear systematic components. For this reason, in bioenvironmental studies, sometimes, suitable generalized linear models (GLM) are used. However, in the presence of various auxiliary variables, such GLM could be very complex and unpractical to a certain extent.

There is a greater problem with statistical modeling and analysis of bioenvironmental studies. With the able help from environmental scientists, in the West, it has the mechnary of having a network of stations or sites where environmental pollution data are recorded on a regular basis, and referred to the regulatory agencies for their monitoring of the environmental pollution. On the other hand, there are also various epidemiologic studies, mostly observational, that aim to relate mortality and morbidity pictures to the environmental pollution and other hazard picture, and thereby to prescribe the impact of bioenvironmental hazards on human health and life. This picture can not be complete without the missing link: how specific environmental factors are related to such epidemiologic findings. For example, there is a common belief that smoking (active or passive) is related to lung cancer. We may gather the prevalence of smoking in an area and relate it to the incidence rate of lung cancer in the same area. But, without an etiological information (or causal-effect), how can we relate high cancer rate to higher proportion of smokers? There could be some other explanatory variable(s) (like familial effect and drinking habits) which might provide a better explanation. Of course, it is often difficult to conduct an experiment involving human subjects for drawing statistical conclusions. For that reason, first some laboratory studies are made on subhuman primates, and their findings are then extrapolated to human beings. This comes under the jurisdiction of dosimetry and animal studies. Even so, in terms of metabolism and other factors, human response could be quite different from such subhuman primates, and hence the statistical conclusions can not be transmitted to human being without critical appraisal of physiological as well as environmental differences. Towards this goal, during the past thirty years or so, in the West, controlled clinical trials have been administered on selected human groups, and guided by their findings more thorough appraisal of biological factors are planned. In terms of statistical mod-
eling and analysis, such dosimetric studies and clinical trials have revealed some methodologic challenges, and some resolutions have been made. In this respect, traditional parametric models have been deemphasized and nonparametrics as well as semiparametrics have been advocated. A good deal of such findings can be found in the various chapters in the volume edited by Sen and Rao (2000).

Having discussed the basic methodologic issues relating to the health hazards from our environment and ecosystem, we should also discuss briefly the use and abuse of statistical packages that have literally flooded the users’ market. Basically, we encounter voluminous datasets in such studies, and modern advances in information technology has enabled mechanisms to collect and analyse such datasets. However, as has been pointed out before, the process of data collection is itself very important for statistical modeling, and on top of that statistical analysis should conform closely the underlying methodology. Unfortunately, because of model complexities and nonstandard methodologies appropriate for those, in many cases, use of standard statistical software packages could be misleading and could lead to imprecise or even inconsistent conclusions. Therefore, we have the obligation to develop side by side appropriate statistical software packages that could be used more validly in bioenvironmental risk analysis. If winter is here can spring be far away?

**Integrating measures of poverty and other socio-economic features**

Measures of socio-economic inequality, and poverty indexes take into account the proportion of population belonging to such a class, their mean level of income (or similar response variable) and some inequality measures, such as the Gini coefficient. Basically, there is a subtle quantification of the underlying response variable and in that way, the mean as well as inequality (concentration) measures are well defined. In a broader context of diversity or distributional inequality, there may be a relatively more prominent qualitative flavour. This, in turn, raises the question on the suitability of moment-like measures in such formulations. An extreme case is a multi-dimensional contingency table, without an inherent quantitative trait, for which we have qualitative variation. On the other hand, in poverty indexes there is a subtle monotonicity condition (under stochastic ordering) and violation of which may diminish the rationality and utility of an
index. Chatterjee and Sen (2000) proposed some modifications and developed some stochastic ordering monotonicity preserving diversity measures which are suitable even for qualitative data having some partial ordering properties. Keeping that in mind, we consider a general class of socio-economic measures and examine their Lorenz ordering and stochastic ordering properties.

**Socio-economic features**

We live in a world that is intermittently going through changes in its value system, ethics, religious faiths, cultural outlooks, and above all evolutionary socio-economic (social welfare and economic policy) deformations. Yet in this environment we speak of economic well being, social equity and equal opportunity - though they could be highly illusive. In resources inventory, developmental economy, planning and in other problems too, we have a strong mathematical economics flavour, it is of interest to appraise the role of stochastics in such deterministic models. On a regional or country basis, the governments have the responsibility to fathom out the state of economic and social well-being, and in this respect, even health-economics is not outside the pandora’s box. On top of that international agencies like the United Nations, UNESCO, FAO, ILO, IMF, and World Bank, aspire to have this quantitative assessments across the nation or regions, and over the passage of time as well. The fancy term *Quality of Life* (QOL), albeit having its genesis in health management and care, is being used in a much broader field of socio-economic investigations. The game is to quantify all these more or less qualitative features, and socio-economists take great pride in this task, yet the key role of statistical science can not be ignored in this respect. There are some compatibility issues, and some other intricate features that definitely merit critical statistical appraisals. It is in this spirit, I would like to discuss some of these excursions in socio-economics, and elaborate statistical perspectives.

From time immemorial, wealth and power have been the key factors in the documentation of the well being of a community or society, although, it might be very difficult to define precisely (real) wealth or potential power. Leaving aside the more political scenario with power (that could be related to natural resources as well as industrial, scientific and technological advances), let us concentrate first
on wealth, real income and the assessment of poverty as well as affluence of a community or society. No matter which community or society or country we look at there is a mixture of the so called poor people, the rich or affluent ones, and the go-in-between middle class people. However, the demarcation of a poverty line and an affluence line is a highly delicate task, and can not be set in the same norm everywhere or over a span of time. The first and foremost task is the assessment of real income or wealth. In this assessment there may be quite a number of explanatory or auxiliary variables, many of which could be qualitative (or at best polychotomous categorical) in flavour. Therefore, there is a genuine need for the social sciences researchers to incorporate statistical reasoning to arrive to a single criterion variable that relates to the real income or wealth on a personal or household basis; in the latter case, the size of the household is an important explanatory criterion too.

Let us denote the real income variable by $X$, and assume that $X$ has a distribution function (d.f.) $F$, defined on $\mathbb{R}^+ = (0, \infty)$. Also, with respect to this d.f. and with due consideration on the real interpretation of poverty and affluence, we conceive of two numbers $(0 <) \rho < \xi (< \infty)$, termed the poverty line and affluence line respectively, such that a person (household) having a real income below $\rho$ is termed poor, and above $\xi$ is termed rich. With that in mind, let us define

$$\alpha = F(\rho) \quad \text{and} \quad \gamma = 1 - F(\xi), \quad (0.1)$$

so that $\alpha$ and $\gamma$ stand for the proportion of poor and affluent people respectively. In the simplest way, these numbers are often used to define the well-being of a society or community or country. However, they do not reflect the extent to which poverty and affluence persist. To have a more meaningful treatise, we therefore need to look into the poor (and affluent) income distributions. We consider here the case of poverty, and a very similar case can be considered for affluence. Let

$$F_P(x) = \alpha^{-1} F(x), \quad x \leq \rho, \text{ and } 1, x \geq \rho. \quad (0.2)$$

As in Sen (1999), we consider the rescaled poor income distribution

$$F_P^o(y) = F_P(yp), \quad 0 \leq y \leq 1. \quad (0.3)$$

Further, let $\mu^o$ be the mean of the d.f. $F_P^o$, and let $G^o$ be the corresponding Gini
coefficient. Thus,
\[ \mu^o = \int_0^1 y dF^o(y), \quad G^o = (2\mu^o)^{-1} \int_0^1 \int_0^1 |y - z| dF^o(y) dF^o(z). \] (0.4)

Then a commonly used poverty index, due to A. K. Sen (1976), is the following:
\[ \pi_S = \alpha \{1 - \mu^o(1 - G^o)\} = \alpha \{G^o + (1 - G^o)(1 - \mu^o)\}. \] (0.5)

Since \( \mu^o, G^o \) both lie in the unit interval \((0, 1)\), \( \pi_S \) lies in the interval \((0, \alpha)\), and it reflects the impact of both the mean income and income inequality among the poor. A larger \( G^o \) for a given \( \mu^o \) makes the index larger, while for a given \( G^o \), \( \pi_S \) decreases with the increase of \( \mu^o \). Of course, the distribution being defined on \([0, 1]\), the parameters \( \mu_o \) and \( G_o \) are interrelated and their covariation plays a basic role in the interpretation of the poverty index. From robustness perspectives, Sen (1986) considered another version wherein the arithmetic mean is replaced by a geometric mean. Specifically, he advocated
\[ \pi^*_S = \alpha \{(1 - \mu^o)^{1-G^o}\}. \] (0.6)

Note that \( \pi_S, \pi^*_S \) are unit-free (as is \( F^o_P \)), but not necessarily invariant under arbitrary increasing transformation on the original income variable. This last property is important especially when income has a significant qualitative component that may make it difficult to quantify it precisely and hence provokes ordinal categorical data models (Sen 1999). It is not uncommon to have the poor income distribution on a set of ordered class intervals, and bearing in mind the qualitative undercurrents, a categorical data model seems to be quite reasonable. With that motivation, Sen (1999) pursued the idea of incorporating the Gini-Simpson diversity index in a more general utility-oriented formulation and proposed some allied measures. These are also related to the so called diversity measures considered by Rao (1982). Nayak (1986) and Nayak and Gastwirth (1989) used Rao’s quadratic entropy measure in a distributional (inequality) setup, but confined to ordered categorical data models. Consider a categorical data model relating to \( C (\geq 2) \) categories, indexed as \( 1, \ldots, C \) with respective probabilities \( P_1, \ldots, P_C \), so that the point \( P = (P_1, \ldots, P_C)' \) belongs to the \( C \)-simplex \( S_C = \{x : x \geq 0, x'1 = 1\} \). The Gini-Simpson index (of diversity) is
defined as

\[ I_{GS}(P) = 1 - P'P = \sum_{j=1}^{C} P_j(1 - P_j) = \sum_{1 \leq j \neq k \leq C} P_j P_k. \] (0.7)

A natural extension (Sen 1999) of this is the utility-oriented one:

\[ I_{UGS}(P) = \sum_{j=1}^{C} u_j P_j(1 - P_j), \] (0.8)

where the \( u_j \) stand for some utility scores. \( I_{GS} \) is a special case of Rao’s quadratic entropy measure:

\[ I_R(P, D) = \sum_{j=1}^{C} \sum_{k=1}^{C} d_{jk} P_j P_k, \] (0.9)

where the \( d_{jk} \) stand for the distance between the categories \( j \) and \( k \). Thus, the \( d_{jk} \) are all nonnegative, and \( d_{jj} = 0, \forall j \); if we set \( d_{jk} = 1, \forall j \neq k \) then \( I_R = I_{GS} \).

A poverty or income inequality index serves as a summaritive measure of the income distribution (of the poor). As such, it is generally used in comparative studies of poverty or income inequality of different regions or different communities as well as for temporal variation of the same in a given setup, or more generally, in a spatio-temporal study covering a greater area and a time period. In order to satisfy the basic compatibility criteria, there are certain properties (or axioms) that such measures should possess. Among these axioms, the two most important ones are the following:

(A) An index should be nondecreasing under left-shift of the reduced income distribution (\( F^o_P \)), or in other words, it should be nonincreasing under a stochastic ordering on \( F^o_P \).

(B) An index should be subgroup or ANOVA decomposable, that is, if a population is composed of several subpopulations, then the related overall index should be decomposable into two nonnegative components representing respectively the average of the within subgroup measures and the between subgroup divergence.

The last property has been extensively studied in the literature (Nayak 1986; Nayak and Gastwirth 1989, A. K. Sen 1997, Sen 1999). All the measures referred to earlier satisfy this subgroup decomposability condition. Shorrocks (1980) considered some additively decomposable inequality measures; there is a persistent
quantification requirement for which additivity makes sense and entropy functions play a basic role in this context. Coming back to Rao’s quadratic entropy measures, we may represent this in the form

$$Q(F) = \int \int d(x, y) dF(x) dF(y), \quad (0.10)$$

and in the present context, we work with the rescaled d.f., so that the range of integration is $(0, 1)$. Suppose now that a rescaled d.f. $F$ is a mixture of two such d.f.’s, say $F_1, F_2$ with a mixing coefficient $\omega : 0 < \omega < 1$. Then writing $F = \omega F_1 + (1 - \omega) F_2$ we have

$$Q(F) = \omega Q(F_1) + (1 - \omega) Q(F_2) + \omega (1 - \omega) \int \int d(x, y) d[F_1(x) - F_2(x)]d[F_2(y) - F_1(y)] \quad (0.11)$$

so that in order that the decomposability holds (where the first and second terms on the right hand side represent the within and between components respectively), we need that

$$\int_0^1 \int_0^1 d(x, y) d[F_1(x) - F_2(x)]d[F_1(y) - F_2(y)] \leq 0. \quad (0.12)$$

This is known as the conditionally negative definiteness (CND) condition. Equivalently, we can characterize the CND condition in terms of $Q(F)$ being a concave function on the space of distribution functions. It is also possible to characterize it in terms of $d^{1/2}(x, y)$ being a metric. Whereas this CND condition is easy to verify, it may not necessarily satisfy the monotonicity criterion in (A); the index $I_{GS}$ is a classical example for this.

Let us examine the monotonicity property in (A). Suppose that there are two rescaled d.f.’s $F_1, F_2$ which are stochastically ordered, i.e.,

$$F_1(y) \geq F_2(y), \ \forall \ y \in (0, 1). \quad (0.13)$$

Let $q_j(y) = \inf\{x : F_j(x) \geq y\}, \ j = 1, 2$ be the two quantile functions. Then, note that the stochastic ordering property is equivalent to

$$q_2(y) \geq q_1(y), \ \forall \ y \in (0, 1). \quad (0.14)$$
It is easy to show that $\pi_S^{(j)} = \pi_S(F_j)$ can be written as

$$\pi_S^{(j)} = \alpha \{ 2 \int_0^1 \{ 1 - q_j(y) \} (1 - y) dy \}, \quad j = 1, 2,$$

when both the d.f.’s are continuous. As such, in this case, by the last two equations,

$$\pi_S(1) \geq \pi_S(2) \text{ under } F_1 \geq F_2 \text{ a.e.}$$

(0.16)

The picture could be different when the d.f.’s are not continuous (as is typically the case in the current context).

It is also possible to compare the d.f.’s $F_1, F_2$ directly without comparing them by a single measure (such as the $\pi_S$). We define the mean $\mu$ and quantile function $q(y)$ as in above and denote by

$$L_p = \int_0^p x dF(x)/\mu, \quad p \in (0, 1).$$

(0.17)

The graph $(p, L_p)$, $0 \leq p \leq 1$, is known as the Lorenz curve; it lies below the diagonal line $L_p = p, 0 \leq p \leq 1$, touching the two tips $(0, 0)$ and $(1, 1)$, and the area formed by the Lorenz curve and this diagonal line is termed the concentration index. If there are two rescaled d.f.’s $F_1, F_2$, we say that a Lorenz ordering holds if one curve lies above the other; in symbols

$$F_1 \succ L F_2 \text{ if } L_p^{(1)} \geq L_p^{(2)}, \forall p,$$

(0.18)

where $L_p^{(j)}$ refers to the Lorenz curve for $F_j, \quad j = 1, 2$. There has been an extensive statistical literature on Lorenz ordering (Foster and Shorrocks 1988). In the present context we may like to know whether stochastic ordering and Lorenz ordering are isomorphic, and if not whether or not one implies the other. The answer is in the negative, as may be verified with some simple examples (Chatterjee and Sen 2000).

Let $F_1, F_2, F_3, F_4$ be the uniform d.f. defined on $(1/8, 3/8)$, $(1/6, 5/6)$, $(3/8, 5/8)$ and $(1/4, 3/4)$ respectively, all subsets of the unit interval $(0, 1)$. Then we have

$$
\begin{align*}
q_1(p) &= 1/8 + p/4, \quad L_p^{(1)} = p(1 + p)/2; \\
q_2(p) &= (4p + 1)/6, \quad L_p^{(2)} = p(1 + 2p)/3; \\
q_3(p) &= (2p + 3)/8, \quad L_p^{(3)} = p(3 + p)/4; \\
q_4(p) &= (2p + 1)/4, \quad L_p^{(4)} = p(1 + p)/2.
\end{align*}
$$

(0.19)
Hence note that

\[ q_1(p) \leq q_j(p), \ j = 2, 3, 4, \ \forall p \in (0, 1), \]
\[ L_p^{(1)} \geq L_p^{(2)}, \ L_p(1) \leq L_p^{(3)}, \ L_p^{(1)} = L_p^{(4)}, \ \forall p \in (0, 1). \quad (0.20) \]

Thus, whereas the stochastic ordering of \( F_1 \) vs \( F_2, F_3, F_4 \) holds in the same direction, their Lorenz orderings are not concordant.

Foster et al. (1997) for the rescaled poor income distribution \( F_p^o \) defined the income shortfall scores as \( g(y) = 1 - y, \ y \in (0, 1) \) and for a suitable \( \gamma(> 0) \), considered a poverty measure

\[ I_\gamma = \int_0^1 |g(y)|^\gamma dF_p^o(y). \quad (0.21) \]

For \( \gamma = 1 \) this measure reduces to the income gap ratio. While their measure satisfy the stochastic ordering property, they may need additional conditions to satisfy other axioms formulated by A. K. Sen (1976).

In all these measures, there is a natural emphasis on the actual income variable (rescaled to the poverty level) or suitable quantitative utility scores. There are some situations where it may not be possible to have these precise quantification, and hence, data are collected in more qualitative flavour, resulting in categorical data models without possibly a linear ordering of the categories. These refinements are considered below.

**The Sumner Paradox**

Andy Sumner has commented on the status of poor to middle-income countries and the cronological change of their poverty picture with some reference to India. India, like China, Pakistan and Indonesia, used to be previously listed under the low-income countries but a few years back managed to creep into the middle income countries bracket. This classification, by the World Bank, was mainly based on the average income level, and in India’s case, the information technology and pharmaceutical industry growth have elevated the average income status and helped in pushing India to a middle-income group. Similarly, the World Bank interpreted poverty by the number (or proportion) of poor people. In India’s case, the number of poor people jumped from about 435.5 millions in 1990 to about
455.8 millions in 2005. This prompted Sumner in examining the paradoxical relation between average income and the classification of poor to middle-income to affluent countries. He claimed that the world’s poorest billion-plus residents now live overwhelmingly in countries like India classified as ‘middle income’ by the World Bank. While China managed to exhibit, at least outwardly, that they have reduced poverty (than India), in India’s case, in 1990 it has 24 percent of the world’s poor which jumped to 33 percent in 2005. He has claimed that in 1990, about 93 percent of world’s poor used to live in the low-income countries while in 2007-08, three-quarters lived in the middle income countries.

Looking back at this picture from a statistical cum econometric objective, I could say that the reservations some of us might have in his assessment are mainly due to the World Bank’s adoption of the average income and the number of poors in their classification, and this drawback has been echoed in Sumner’s narrative. As such, I may comment on the following perspectives:

1. Income inequality relating to each and every sector of a country must be appraised thoroughly for a complete breakdown of the income distribution and use of a more meaningful measure for classification into low- or middle-income country.

2. In India’s case, there may not be any realistic study of the income distribution, particularly when a large class of population may not have a documented income. There is some tangible information on the expenditure distribution but it is difficult to regress the expenditure distribution to the corresponding income distribution.

3. It is well known that the (arithmetic) mean income of a country is highly nonrobust and could be very nonrepresentative. For example, like the very poor people, the actual wealth or real income of excessively rich people may not be mensurable, especially in countries like India, Pakistan, Nigeria and Indonesia which are all now under the middle-income bracket. A major part of the unreported income of the affluent people (including upper-middle income class) is a stumbling block for any realistic study of average income. In statistical analysis, it is often preferred to have the median income rather than the average income.
4. Child labour and family labour practice, especially, in the agriculture and domestic work sector, may have some concomitant of income but has not been properly documented or appraised in the Indian subcontinent.

5. Simply by the number of poor people we can not judge the level of poverty. Incidentally, in the present case, there has been an increase of the population over the studied period (of 15 years). Secondly, the poverty line might have changed over the same period. The interpretation of poverty in terms of income alone makes it more difficult to justify. For example, in India, for BPL people, cereals are provided at a subsisised rate, and hence, even some people over the BPL might have unscrupulously been classified in the BPL category. That might have contributed to an elevation of the number of poor people.

6. As discussed earlier, a poverty index is a better measure than the proportion of the population in the BPL category. If there is no debate on this issue, it might be more interesting to regress a suitable poverty index on the poor versus middle-income classification. This, however, needs the assessment of the ‘poor income distribution’ providing the entities: income gap ratio, average income of the poor and the Gini-coefficient of the poor income distribution. Since in the Indian case, the income distribution has not been reliably assessed, any adoption of these poverty indexes may not seem to be reliable either. Nevertheless, if the World Bank would have used the median income (instead of the average income) and some poverty index (instead of the number of poors), the conclusions could have been somewhat different and more interpretative at the sametime.

7. The average income is dependent on the affluent class also. Thanks to the information technology and liberal business and industry policies, the number of people in the upper income sector has gone up tremendously, and the number of people in the extreme high income group is also rising. However, because of population growth, especially more drastically in the poor sector, the number of poors is also increasing in an unabated rate. On top of that it is very unlikely to fathom out the real income of the
affluents; their perks may be much more than their manifested income. These deficiencies have a significant impact on the income distribution of the affluent and the overall income distribution as well. A comparison of the overall income distribution of the country, instead of a single summaritative measure will produce a better comparison.

8. Migration of population from adjacent countries, particularly in the poor sector, might have tilted the picture, raising the number of poors above the statistical figures. In India’s case, not only this migration from Bangladesh and other countries have been unabated over decades, that has contributed significantly to the increase in the number of poors. Migration from India to the Arabian countries, although of shorter duration, not only have the middle-income status but also led to an elevation of the average income. Migration of Indians to UK/USA and other countries have a somewhat different pattern; the so called Indian diaspora have mostly technical and professional background with comparatively higher incomes, and they have very little to do with the elevation of the number of poors. Such NRI (nonresident Indians) have also raised the income level in India directly or indirectly without increasing the number of poors. However, there has been a significant change of the income distribution in India, affecting the very definition of the BPL and the poor people. A poverty index should be more meaningful instead of the number of poors.

9. What used to be a luxury at one time has become a necessity at the present time. For example, mobile phones, (coloured) TV and other electronics have invaded people from all walks of the society. This has changed the norm of poverty and calls for adjustment of the poverty line accordingly (systematically and progressively over time). The income distribution of 1990, consistent with the value of Indian rupees at that time, is by no means comparable to the 2005 income distribution and the huge transformation that reshaped the Indian economy and the classification of the poor versus middle-income people.

10. Some facilities which used to be more prevalent at the social level may no longer be available at the present time. For example, cost of education
has soared up tremendously while among the poor people the quest for secondary education and even some college level education is more persistent now than before. Similarly, the prevalence of 'charitable dispensaries' for the medical treatment of the poor and destitutes might have dried up to a greater extent in the past twenty years. That might make the poors more poor to cope with this social change. Simply the number of poor people fails to capture this composite picture.

11. The income inequality in the Indian population has been escalating at an alarming rate. Like the average depth of a pond or river, the average income of a country, no matter how it is compiled, fails to capture the entire picture. Perhaps, statistical comparisons, such as the Lorenz ordering or right-tiltedness, as discussed before, should be a better alternative.

Our criticism is by no means directed to Andy Sumner, rather it relates to the inadequacy of the World Bank's adoption of the average income and more controversial number of poors in their classification. Whereas the population in Northern Europe (sans United Kingdom) is fairly stationary and homogeneous for which the number of poors makes good sense, in many other countries (like USA) the population is far from being homogeneous and stationary, and the adoption of the number of poors as a measure of poverty is highly controversial. In some of the populous countries, especially in the South Asian region, demographic features, its noticable growth rate and high level of heterogeneity may label the number of poors as a measure of poverty level less acceptable. Development and management studies are needed to critically appraise this situation and suggest more reliable and more meaningful measures for such chronological studies. Statistical planning and analysis perspectives are important for more serious studies. This will be communicated in a separate follow-up study.

Health Economics and Qualitative Poverty

In 1993, WHO has launched a Project WHOQOL on quality of life with an eye to have a global picture of human health and the impact of the bioenvironment on it. QOL has been interpreted mostly in a health related perspective, though this interpretation is undergoing an evolution in a much broader perspec-
tive. In the WHO interpretation QOL is defined as an individual’s perception of their position in life in the context of the culture and value system in which they live and in relation to their goals, expectations, standard and concerns. The QOL interpretation has also been localized for a more specific subclass of population. Consider, for example, a class of people in a specific geo-political area who have undergone a major medical/surgical treatment (e.g., cancer, heart problems, chronic disorder, depression, and many other long-effect diseases/disorders), so that for the rest of their life, their physical, mental and functional abilities may be impaired to a greater or lesser extent. Parallel to the case of economic poverty, the main concern here is the quality of life (i.e., the deficiency) these people have at this stage.

As in the case of poverty, a crude measure such as the proportion of the population afflicted with such a disease or disorder does not convey a representative picture of the actual state of affair with these people. A second possibility is to incorporate the measure MRL (mean residual life) that attempts to compare the normal cohorts with the afflicted ones. However, that may still be not totally representative. For example, for a common disease/disorder there may be two treatments, say A and B. Treatment A is known to be effective in prolonging the MRL albeit without much care of the actual functional ability of the afflicted persons, while Treatment B is primarily geared to enhancing the functional ability though possibly compromising on the MRL. For this reason, quality adjusted life (QAL) has emerged as a more usable measure that takes into account the longevity following such a disease/disorder as well as the state of their health status. In most of these cases, we typically have a multidimensional categorical data model with some (partial) ordering of the categories, and the basic statistical issue is to take into account both the QAL and MRL with a view to formulating a more meaningful measure.

Chatterjee and Sen (2000) have considered a general class of indexes with special emphasis on categorical data models without possibly a linear ordering of the categories. We can express such as index as

\[ I_{CS} = \alpha\{\sum_{j=1}^{C} \sum_{k=1}^{C} d_{kj}P_i P_j\} = \alpha\{P'DP\}, \]  

(0.22)

where the \( C \) categories have respective probabilities \( P_1, \ldots, P_C \), \( P = (P_1, \ldots, P_C)' \)
and $D = ((d_{ij}))$ is a symmetric matrix with nonnegative elements; $\alpha$ stands for the proportion of the population that is under consideration (e.g., poor people in poverty studies). The poverty index $\pi_S$ is a bonafide member of this class where the matrix $D$ has a definite quantitative structure that depends on the individual cell variate values. Chatterjee and Sen (2000) have shown that under an increasing north-westerly trend (INWT) property of $D$, the stochastic ordering property of $\pi_S$ extends to this entire class.

Let us turn back to the QOL context where there be a more dominant qualitative flavour for the different categories, though it might be possible to identify an underlying partial ordering. This provokes the use of suitable grades or utility scores for the categories and replacing the role of income-gap ratio by such grade-gap ratio, analogous indexes can be formulated. The adaptability or appropriateness of such an index would depend on the appropriateness of the chosen utility scores. When the categories are only partially ordered, we use the notation $i \prec j$ to denote that category $i$ is worse-off than $j$ (with respect to the trait under consideration). Then, a special index advocated by Chatterjee and Sen (2000) is the following:

$$I_{CS}^\alpha = \alpha \{1 - \frac{1}{C} \sum_{i=1}^{C} (\sum_{j:i\prec j} P_j)^2\}. \tag{0.23}$$

This index avoids the use of arbitrary scores and incorporates solely the underlying partial ordering of the categories. In the context of QOL-deficiency (QOLD) such a measure can therefore be advocated. For example, for people identified in the HIV positive class, there are various categories depending on their physical and mental states with the worst state being the death-bed, and the best is the afflicted but still physically fit to meet daily living task. In such a case, the partial ordering is well identified, and hence $I_{CS}^\alpha$ can be used to have an interpretable QOLD measure. In a broader context, if only some partial ordering is preserved it may be better to conceive of some utility scores and define an index in the above fashion. In health measurements, as has been discussed earlier, the complexity of categories and their sheer dimension may dictate the use of Hamming distance type composite measures but possibly using utility scores in the different coordinate variables or attributes. Cost effectiveness and affordability considerations may also dictate the use of suitable utility scores. More composite
measures may be needed to suit the purpose better. Whereas in the case of income distribution, the classification of poor and others can be made conveniently, in QoL and human development assessments such a clear cut ordering is lacking and more socio-iconomic as well as statistical considerations are genuinely needed to formulate a rational classification of poor to reasonable norms. Sans this acceptable norm of classification, any routine use of crude measures could be highly unreliable to imprecise.

**Developmental Economics and Measures**

Developmental economics include a wide area where natural resources as well as socio-ecnomic and geo-political factors all show up in a rather complex synergy. The associated explanatory as well as response variables may not be all quantitative and there may be a persistent qualitative component. In the context of national health plans, we can not disregard a vital component : mental health, outlook on life and social compatability. At the present time, the family structure and family life are undergoing drastic change. The acute competition starting from the kindergarten schools all the way to secondary and college level education (or better training!) has created an enormous stress at all levels; not only the pupils in this phase of life are going to frustrations of all kind but their parent(s), often single, are going through an ordeal of mental tests and social incompatability. This has resulted not only a disarray of attitude towards life but also a tremendous unrest, especially among the younger people. With most of the educated people, both the spouses are now a days working outside the home and their ability to adjust with the day to day family life is also put to test. Infertility among the working couple, more in the upper middle income group, has become a significant factor of modern family life. Our toxicated environment is also contributing towards reproductive toxicology. Developmental biology is receiving good attention from researchers from all walks of social and clinical sciences. Human development is possibly at crossroads with this stress and strain in our daily life. Mental health problems are cropping up at an escalating rate. Terrorism, be it at the domestic or geo-political level, has become a household word, albeit we may not be completely aware of the depth of this problem and its deleterios im-
pact on our society. Modern life-style has also contributed towards this mental health problem and occasional outburst of violence thereof. Congenital mental health problems are also noticeable to a greater extent now than fifty years ago. The transformation from resource sharing joint families to small family units has created major social impasses. Even the parents of working couples are often left out in isolation with their plights at their golden age placed at the mercy of their 'istodevata'. Ironically, many of these parents sacrificed much of their own comforts to raise their child(ren) beyond their means for full education and did not realise that at their golden age, if they survive, they will be left out! Dementia and Alzheimer disorder are not rare in Indian societies, and by no means, they are confined to poor people. Ironically, even among the offsprings, autism is perceived more often now than in the past. Is it really due to the changing environment or the life-style of present day youths? Can these problems be characterised totally by some quantitative disorder or disability? It has been perceived in the West that various irregularities of life-style at the pregnancy stage (of mothers) may affect significantly the chance of autism or other birth-defects and disorders. Can we borrow the basic idea of monetary poverty and formulate parallel measures of mental poverty? To what extent this is linked to human development? Even in the most simple formulation of this mental health phobia, though in principle, the situation is comparable to the poverty assessment task, because of qualitative factors, there is a genuine need to address them in a somewhat different manner. In this respect, the measures discussed earlier provide a convenient channel for formulation of suitable indexes that have certain properties analogous to the QOLD and QAL measures.

It may be tempting to adopt the Sumner approach in regressing the prosperity level of a country on the number of mentally ill people. Alas, even in that simple setup, the assessment of mental health problems is a highly technical task which can not be handled without the formation of mental health plan provisions. Family members, due to social customs, may be shy in reporting any such disorder at the beginning stage, and at a later stage, it may be difficult to put a tab on this disorder. In the West, there are provisions for such autistic children to have school education under supervised guidance, followed by suitable job opening when they are ready to enter that phase. Handicapped people, be it physically or mentally, should have certain facilities to minimise their agony and be allowed to
be a recognizable sector of the society. A national health plan must have sound provisions for such people. We can not indefinitely increase the number of 'Lumbini Parks' for such unfortunates knowing well that even if resources would have permitted us to so, at the end the whole society then be engulfed in a generalised Lumbini Park. Rather, we need to nurture the development of mental facilities of these people and formulate suitable solutions so that they feel comfortable in being a bonafide part of our society. Along with psychiatric treatment, statistical considerations are of utmost importance in this challenging task.

Coming back to the developmental biology, I could make a comment that often the slow progression of human development is linked to extraneous environmental factors - not necessarily due to congenital causes. However, the association of genetic factors with environmental ones can make the phenomenon much more severe and unmanageable. This is the reason why in developmental biology it is important to sort out the genetic basis clinically as far as possible and then create a compatible environment for the nurture of their full human development. At the present time, realising the steady growth of this disorder, health economics, clinical sciences and psychometric to statistical analysis should be harnessed together, to the extent of permissible resources, for the benefit of the society. Otherwise, for our growing society I could end-up with a line from Atulprasad: Tumi jaare falichho niche, se tomaare taanibe pichhe (whom you are pushing down in dejection will drag you there in repercussion). Emotion and intelligence quotients are not related by one-to-one functions but there is ample room to accommodate them in a healthy environment. Society can not run on either emotion or machine intelligence. Health economics should harness emotion and intelligence together and heed to this mental health fortification as well; statistics is indispensable in this context too. If winter is here, can spring be far away!
Selected References


