Chapter 2.3

Diet and Non-Communicable Diseases: An urgent need for new paradigms

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"The voyage of discovery is not in seeking new landscapes but in having new eyes."

***Marcel Proust** (1871–1922), French novelist, essayist and critic.*

Key messages

- Incidence and impact of non-communicable diseases (NCDs) will further increase, and will continue to do so at a younger age than we have been accustomed to in the US and Western Europe.
- NCDs have many risk factors, and lifestyle-altering interventions are necessary to mitigate them.
- Many countries worldwide are rapidly acquiring the characteristics that create a receptive milieu for NCDs.
- More people die annually from cardiovascular diseases (CVD) than from any other cause; approximately one third of these deaths occur in adults aged between 30 and 70.
- NCDs are very difficult to manage with traditional health measures, but innovative interventions do exist, and can be effectively implemented.
- To reduce the prevalence of NCDs, public health needs to engage more actively in the shaping of policies that influence health.
- The food industry should be encouraged to offer a portfolio of nutritious food products and food supplements to fill the nutrient gaps.

The spread of non-communicable diseases

Non-communicable diseases (NCDs) have emerged as the leading cause of human mortality and morbidity in low-, middle- and high-income countries. NCDs are not considered only as social burden; the economic costs of NCDs are also accelerating worldwide. By the year 2030, when the Sustainable Development Goals (SDGs) should have attained their targets, cardiovascular disease (CVD) will be the leading cause of death across the planet, exceeding mortality from HIV, TB, malaria, and maternal & child undernutrition combined. Despite these "costs," not to mention personal disabilities and social ailments, however, little progress has been made to date in limiting or diminishing the NCD epidemic.

The main NCDs include diabetes, cardiovascular disease (CVD), chronic respiratory disease, cancer, and mental health conditions. Obesity and overweight are frequently associated with the presence of one of more of these NCDs. In this chapter, the major emphasis will be on overweight and obesity and the root associations of these conditions with cardiovascular disease and diabetes. The text is presented as key themes that need to be considered in developing new paradigms to diminish the burden of NCDs. An overview of the basic epidemiology of these diseases will be considered, and this will be followed by recognized and underappreciated drivers for NCDs. The economic cost of NCDs will be considered, along with interventions and challenges to the new paradigms presented for successful control of this major burden to human health and productivity.

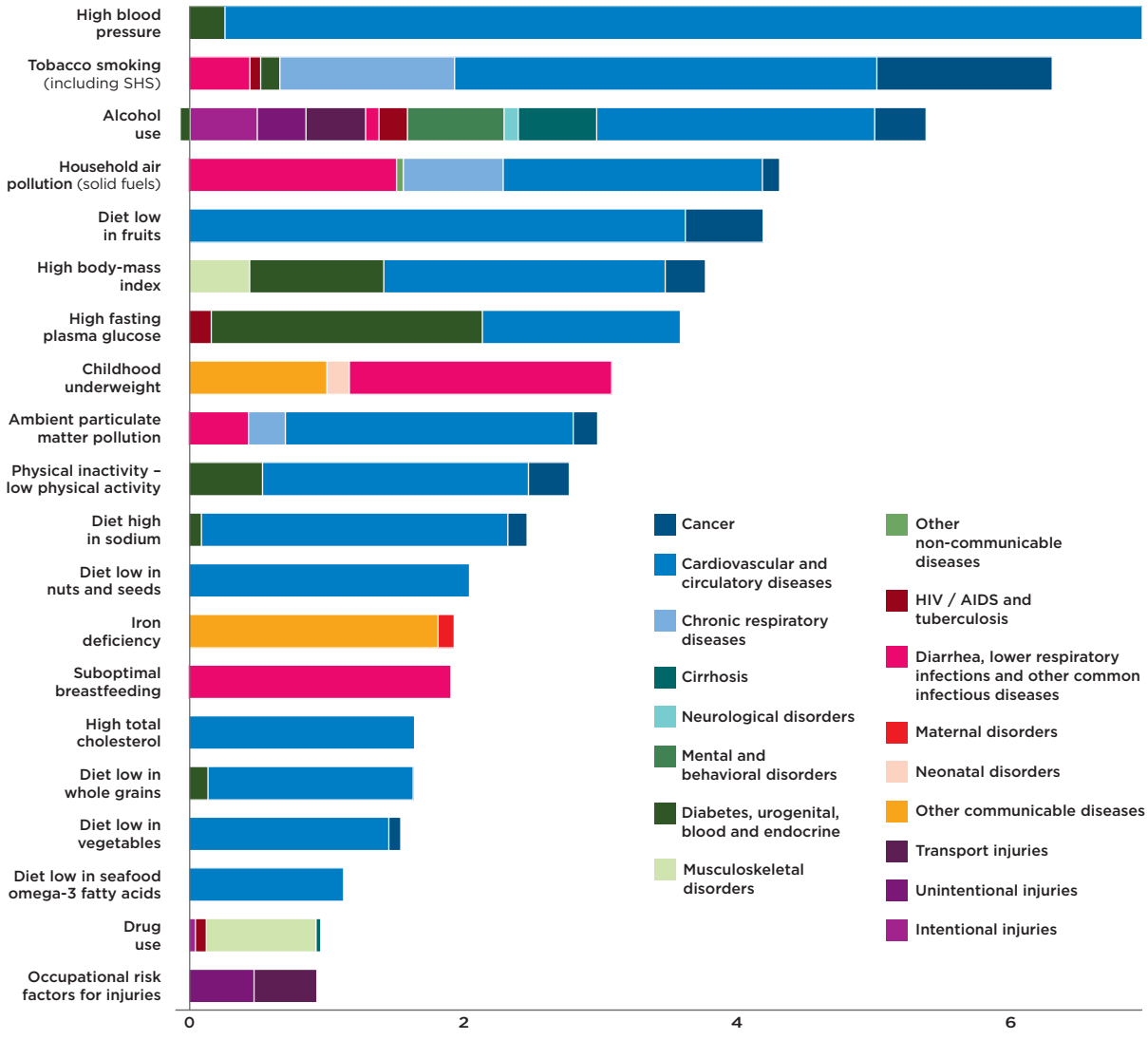
The global rise in the incidence of type 2 diabetes has been fueled, in part, by the consumption of carbonated beverages with a high sugar content. Source: Ricardo Uauy

1 Basic epidemiology of non-communicable disease risk factors related to diet

Aside from the role of genetics, the dominant risk factors for non-communicable diseases are behavioral; they relate to unhealthy diets, inadequate physical activity, exposure to tobacco smoke (and air pollutants), and excessive alcohol use. By and large they can be avoided, and if recognized at any time over the life course, they can be modified by changes in behavior and lifestyle, and/or with well-tolerated and inexpensive medications. However, because the risk factors are embedded in behavioral, cultural, and political realities, modifying the up-stream drivers is very difficult and requires the engagement of different sectors of government and other groups.

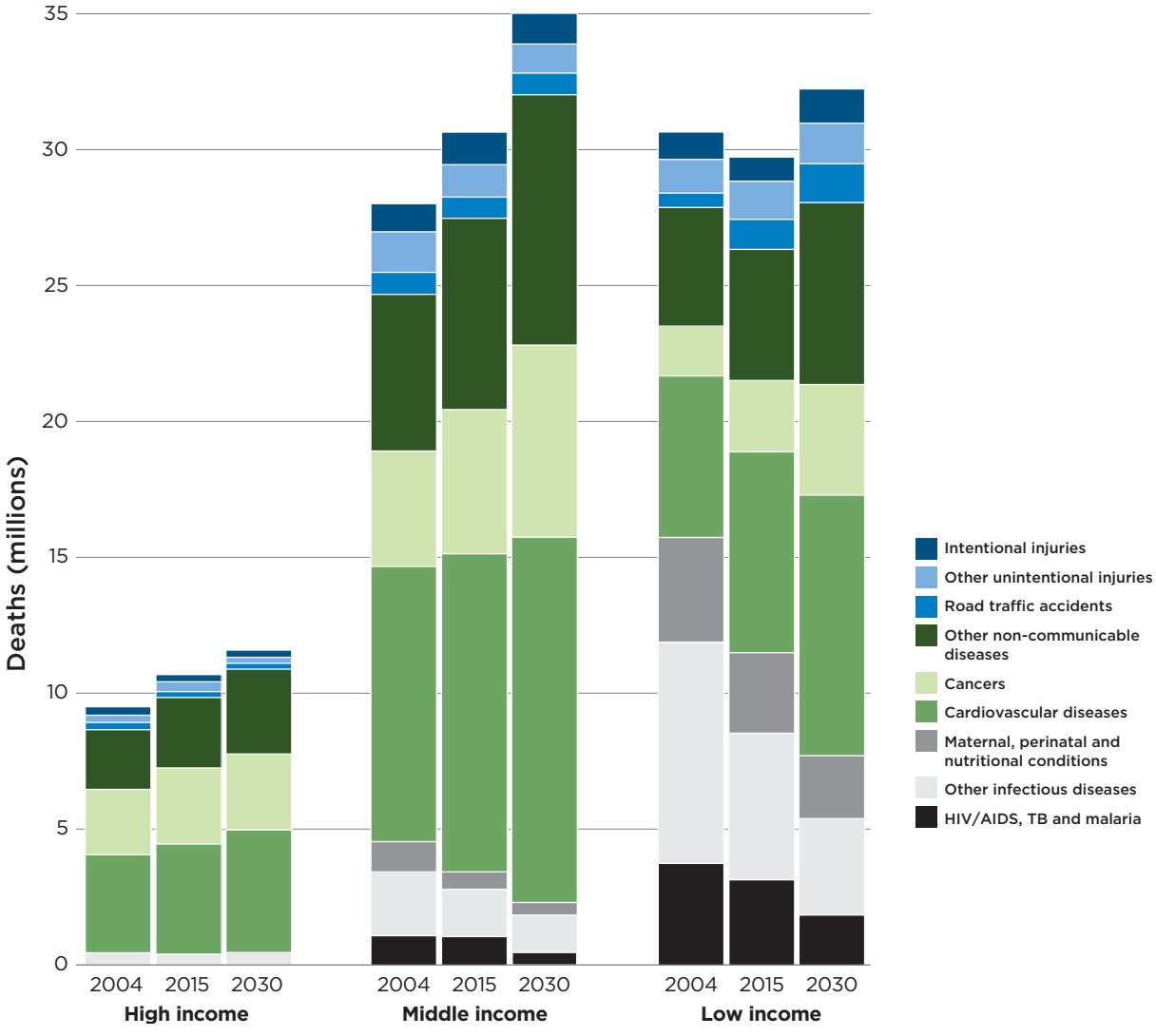
The major NCDs related to diet are cardiovascular diseases and diabetes mellitus (DM). There are also several others: respiratory diseases, mental health disorders, lower extremity arthritis secondary to obesity, several cancers, and dental caries. The key diet-related risk factors for CVD and DM include overweight/obesity, hyperglycemia, elevated blood lipids, and hypertension. (Here we do not focus on alcohol or tobacco, although the former could be included under the diet umbrella.) The leading risk factors for CVD (ranked by disability-adjusted life years, DALYs) in every region of the world are of dietary origin, and this excludes hypertension, which is categorized separately and is universally number two. (In Eastern Europe, hypertension is first and dietary second – see **Figure 1**). Hypertension, however, obviously has substantial contributory diet-related mechanisms.[1]

Figure 1 | **Burden of disease attributable to 20 leading risk factors in 2010, expressed as a percentage of global disability-adjusted life years(DALYs).** *SHS = second-hand smoke*



Source: Lim SS et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease study, 2010. Lancet 2012;380:2224–2260.

Figure 2 | **Projected deaths by cause in high-, middle-, and low-income countries, 2004 to 2030**

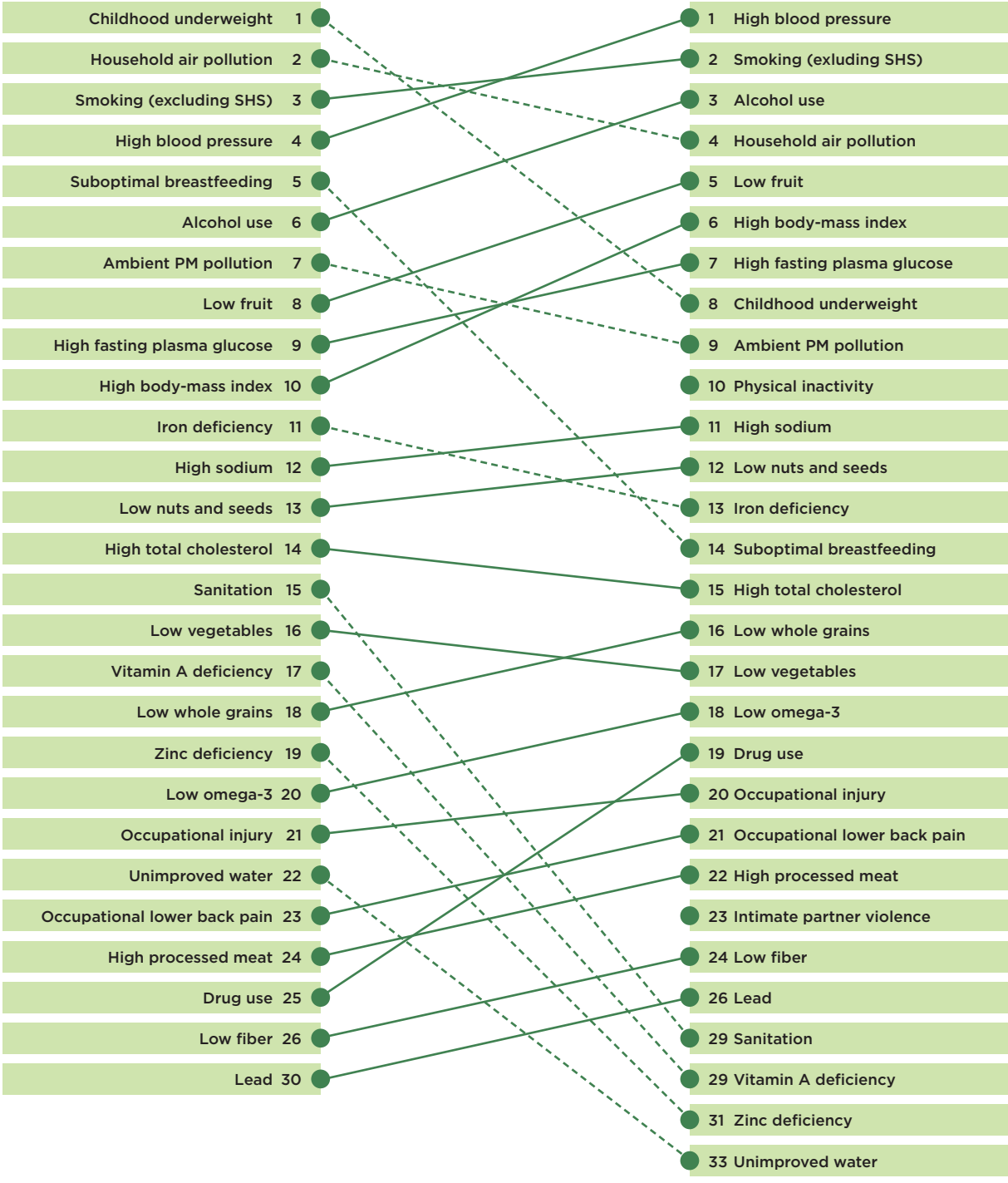


Source: WHO Global Burden of Disease 2004 Update, p. 24, "Projected deaths by cause in high, middle, and low income countries, 2004 to 2030." http://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/. Accessed May 25, 2016.

Figure 2. illustrates how by 2030 CVD will cause the largest number of deaths not only in developed countries but also in low- and middle-income countries (LMICs), exceeding the mortality from HIV, TB, malaria, and maternal-child undernutrition combined.

From the Global Burden of Diseases (GBD) 2010[2] we learn that in the two decades between 1990 and 2010, the disease burden attributable to hypertension, alcohol consumption, high BMI, high fasting blood glucose, high sodium intake, and low fruit, vegetable, nut and whole grain consumption all increased significantly, while the disease burden attributable to childhood underweight, suboptimal breastfeeding and micronutrient deficiencies all decreased significantly (**Figure 3**). There is little likelihood that these trends will change in the near future in all regions of the world. The NCD expression will only increase, and will do so at a younger age than we have been accustomed to in the US and Western Europe.

Figure 3 | **Global risk factor ranks for all ages and sexes combined in 1990 (left) and 2010 (right).**
PM= particulate matter; UI= uncertainty interval; SHS= second-hand smoke



Source: Lim SS et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease study, 2010. Lancet 2012;380:2224–2260.

While the disease prevalence in most of Sub-Saharan Africa (SSA) seems relatively benign as far as expressed disease is concerned, the recent changes in the CVD risk factor profile tell a different story. In SSA between 1990 and 2010, hypertension has increased by 60%; dietary risk factors have increased by 45%; the prevalence of high plasma glucose has increased by nearly 30%; and, most impressively, the prevalence of a high BMI has tripled. In 2010, more than a third of the disability in SSA originated from non-communicable diseases, and CVD accounted for 6.8% of the total. While ischemic heart disease remains uncommon in SSA, stroke rates approach those in the developed world, probably related to a rapid increase in hypertension and inadequate methods to control it. No CVD risk factor has decreased over the past 20 years (2013 data). We have seen this scenario before; we know how it will end if no altering interventions are introduced. We know from the INTERHEART study[3] that "a risk factor is a risk factor is a risk factor." So the present trajectory of SSA will take this region to a NCD health picture much like Latin America or South East Asia in the next generation. And the speed with which these countries will travel to those destinations will be rapid. The drivers that accelerate this transition were discussed in Section 2.2.

Increasing wealth and urbanization are key drivers of NCDs.
Source: Donated by Jo Wilson.

Lack of access to integrated healthcare services for people who suffer from CVD and other NCDs is also an issue. Processed foods high in trans fats, saturated fats, sugar and salt, plus sugar-sweetened beverages, are associated with increased risk of hypertension, diabetes, elevated cholesterol and CVD. Increased urbanization and use of motorized transport may contribute to sedentary lifestyles, which have detrimental implications for cardiovascular health.[4]

The Global Burden of Ischemic Heart Diseases data extracted from the GBD 2010 Study[1] charts the risk factor profile of the WHO global regions. In the high-income, advanced economies in North America, Western Europe, the Asia Pacific region, and Australasia, the profiles are of a decreasing risk factor burden, with the exception of obesity. In all other regions, the profile is increasing.

In order to address these challenges, a broad array of nutrition-specific and collateral initiatives will be required to provide appropriate food to the growing populations worldwide. Key stakeholders must interact and align with one another to overcome the nutritional challenges of societies as they change. An enabling environment should be created to encourage food manufacturers to produce a wide array of affordable, nutritious food products with reduced fat, sugar and calories in combination with appropriate levels of essential (micro)nutrients. Governments need to collaborate with the food industry and:

1 provide incentives (such as regulatory frameworks that stimulate innovative solutions);

2 make sure that the required standards are met in order to protect consumers; and

3 provide education to stimulate consumers to make more health-conscious choices.

2 Contemporary drivers of NCDs and their risk factors

Whereas diet and exercise are preventable risks factors of NCDs, the hard-to-prevent and major drivers of NCDs are increasing wealth, urbanization, air pollution, the information revolution, and global marketing. With the exception of urbanization, none of these have been given much space on the palette of public health, and they are rarely covered in the academic public health curriculum.

Urbanization is a global trend which is also evident in the emerging economies as their populations become wealthier.[5] Increasing national wealth is initially an urban phenomenon which then seeps back to the countryside via remittances, increased travel, and an increasingly well informed rural population. In the city, women join the work force, further disrupting the traditional family dynamics beyond the effects caused by the migration itself. Employment rather than farming becomes the norm. With the growing tendency toward urbanization, it can be anticipated that the dietary profile will significantly change, and an adaptation to a more Western pattern appears likely.[6] The situation for significant parts of the population will change from one of too little food to one of too much food rich in energy and poor in nutrients, and with a high component of processed foods. Disposable income is attracted to readily available fast food, sugary drinks, and tobacco. As there is less and less opportunity for communal family meals, out-of-home outlets become increasingly utilized and important, their role being enhanced by effective and innovative marketing. Physical activity and calories burned by physical work plummet and, coupled with the altered dietary patterns, can lead to rapid rises in overweight and obesity.

While health data support the observation that urban life is healthier for children than rural life and that vaccines and primary healthcare are more readily available, children are more exposed to television, computers, and other sedentary activities, all at the expense of physical activity. These distractions may exacerbate the likelihood of overweight and obesity, and these conditions then drive their associated comorbidities, contributing in a major way to increased prevalence of insulin resistance and metabolic syndrome, DM, respiratory diseases, nonalcoholic fatty liver disease (NAFLD), and CVD.

Layered on to these local transitions and exposures are up-stream forces that further fuel NCD risk factors. Regional trade agreements often, if not always, increase the availability of processed food.[16] As urban expectations and experiences migrate back to the countryside, the risk factor profile for NCDs begins to imitate the urban patterns.

3 Costs of non-communicable diseases

We are indebted to the World Economic Forum and investigators at the Harvard School of Public Health for a thoughtful compilation of cost data for these diseases.[8] The data are based on recent cost assessments and are projected forward to 2025, and they include lost opportunity costs. The fiscal burden is grim. In aggregate, the cumulative cost of 5 NCDs (including mental illness) to 2025 is US$46.8 trillion, with the annual cost in the final year, 2025, anticipated to be in excess of US$7T (**Table 1**, overleaf).

Excluding high-income countries and the contribution of mental illness, lower- and middle-income countries are facing an NCD bill of US$14T for diabetes, heart disease, chronic lung disease, and cancer over a 15-year period, of which nearly US$8T is due to diabetes and heart disease, the most diet-sensitive of these diseases.

The fiscal burden of HIV/AIDS and acute communicable diseases is expected to fall rapidly. Control mechanisms, vaccine initiatives, and infrastructure are improving, and are becoming more and more affordable at the same time. The community-based interventions are well understood and are more and more broadly applied. None of this can be said for NCD prevention, and as we have pointed out in Section 2 and will highlight in Section 5, the drivers of these diseases are less well controlled. Much of the burden relates to diet-responsive drivers of social behavior and diet-specific risk factors.

The more advanced the country – i.e., the greater its wealth – the higher the burden will be. Although high-income countries currently bear the biggest economic burden of NCDs, this burden is shifting to low/middle-income countries, which are expected to assume an ever larger share as their economies and populations grow. One can look at these data and conclude that the poorest countries will be spared. However, the number of countries in the least wealthy category – low-income countries by WHO categorization – took up 58% of the wealth pie chart in 1990, but this had fallen to 11% in 2010.[9] In essence, all countries except failed states are rapidly developing, accumulating wealth, and becoming subject to the same societal pressures that have traditionally fostered a receptive milieu for non-communicable diseases

Table 1 | **Economic burden of NCDs, 2011–2030 (trillions of US$ 2010)**

Country income group	Diabetes	CVD	Chronic Respiratory Diseases	Cancer	Mental illness*	Total
High	0.9	8.5	1.6	5.4	9.0	25.5
Upper middle	0.6	4.8	2.2	2.3	5.1	14.9
Lower-middle	0.2	2.0	0.9	0.5	1.9	5.5
Low	0.0	0.3	0.1	0.1	0.3	0.9
LMIC	**0.8**	**7.1**	**3.2**	**2.9**	**7.3**	**21.3**
World	**1.7**	**15.6**	**4.8**	**8.3**	**16.3**	**46.7**

**The numbers for mental illness were obtained by relating the economic burden of all other diseases to their associated numbers of DALYs. Then the burden for mental illness was projected using the relative size of the corresponding DALY numbers to all the other conditions.*

Source: Bloom DE, Cafiero ET, Jané-Llopis E et al. The Global Economic Burden of Non-communicable Diseases. Geneva: World Economic Forum, 2011.

4 Innovative programmatic interventions

As we have demonstrated above, NCDs are embedded in the social, political, economic, and cultural interstices of a society and as such are very difficult to alter or manage with traditional public health measures. Moreover, as most non-communicable diseases have long, asymptomatic incubation periods, the person with precursor risk factors only infrequently sees himself or herself as a patient. However, even if in possession of that understanding, making the time and effort to visit a clinic at the expense of work or child-rearing is all too often beyond the capacity of this insightful patient. Additionally, the clinic is not designed to handle chronic, asymptomatic disease. We explore some of these factors in more detail in Section 5.

Since the routine doctor/nurse/community health worker-patient relationship is infrequently relevant in managing people with asymptomatic, precursor risk factors, and since traditional public health interventions have proved ineffective at a population level, solutions need be found in innovative ways. Before describing four contemporary approaches in different countries, we will describe a model that has worked and stands as a beacon for all who contemplate this dilemma.

Finland transformed the national mortality pattern from the highest CVD mortality in the world to near the mean of Western Europe in 35 years, and did so primarily by modifying the national risk factor profile. What did Finland do, and how did the Finns do it? The environment was unique, but many of the pieces can be transferred; the story offers hope.

Finland is a wealthy, educated, strife-free, homogenous country. Young, primarily male sudden death mortality became a disturbing reality for the population and the government. Being an open society – a crucial factor – there was a bottom-up groundswell of interest in solving the problem, giving enlightened civil servants and political leaders a permit to engage with the problem. One key to success (and one that is rarely discussed) was an economic intervention that was probably essential. Finland has had a salt reduction program (including mandatory high-salt labeling) in place since 1975, and the average salt intake among adult Finns has declined in the interim from 12 g per day to 9.3 g per day in men and 6.8 g per day in women. Also a "healthy choice" label is available for products with lower salt content and improved fat composition. Finland also developed a cold-climate rapeseed and as such could produce its own canola oil while reducing imports of foreign vegetable oil. While the animal fat producers were negatively impacted, the Finnish agricultural sector as a whole was not. Economic considerations are never far from any healthcare intervention, and this salient agricultural development was an important factor in Finland's success story.

Sesame Street in Bogota, Colombia

It is well established that health behaviors initiated in childhood, particularly those related to diet, frequently extend into adulthood. In an elegant and carefully constructed study, investigators in Bogota, Columbia designed a series of interventions to influence the dietary patterns of preschool children 3–5 years of age.[10] The investigation included health messages embedded in Sesame Street (a popular TV program), posters, video games, and songs. Teachers and parents were engaged. At 36 months, the intervention group of children showed a significant improvement in markers of a healthy life style. A much larger study involving a broad cross-section of the region is under way.

A store owner in Pohnpei, Federated States of Micronesia. Note the predominance of processeed foods on the shelves.
Source: Sight and Life.

Mass media programs have been carried out with probable success in Ethiopia, Cambodia and India, but all the studies conducted had methodological flaws. A large randomized radio-based saturation program is currently under way in Burkina Faso with high hopes for a positive outcome.[11] These studies, all of which require government buy-in, point to a future in which public health aims to improve children's access to better nutrition.

Agita São Paulo

The rapid increase in obesity in Latin America in general, and specifically in the catchment area of São Paulo, Brazil, caught the attention of the leaders of multiple societal actors. Global data indicate that 31% of people do not meet minimal levels of physical activity and that the attributable mortality rate of inadequate physical activity is 6–10%. The public health leadership realized that a series of partnerships engaging nearly all aspects of society would be essential to effectively promote physical activity in the 40 million people of greater Sao Paulo.[12] The goal was not to make everyone a runner, but to move as many people as possible up one stage in their physical activity level: the sedentary became walkers; occasional walkers became regular walkers; regular walkers became programmed brisk walkers, etc. In addition to enlisting the support of the global academic community, the leadership engaged multiple partners from non-governmental organizations, industry, media, and multiple government ministries. A strategic decision was to encourage partnerships without requiring financial support or buy-in. This emerged voluntarily. For example, partners such as the metropolitan transport company, the Truck Drivers Radio Station, and the State Secretariat of Environment were all able to design programs for specific constituencies. From 2002–2008, sedentarism declined by about 70% in the state of São Paulo. The World Bank estimated that the program represented a saving of US$310 million a year at cost orders of magnitude less than this. There are now many similar programs around the world – Agita Mundo and Physical Activity Networks of the Americas, for example. Another innovative approach – new and as yet unvalidated as this book goes to press, and US based, but worthy of mention here – is "The Way to Wellville",[13] a national challenge founded by angel investor Esther Dyson. The Way to

Wellville involves five US communities and aims to make significant, visible and lasting improvement in respect of five measures of health and economic vitality over the course of five years. It is hoped that this will permit the mapping of new paths that will enable for entire communities to make changes that result in healthier people and places.

Traditional diet in South Korea

South Korea participated in the nutritional transition, and did so very rapidly. Obesity increased by nearly 40% between 1990 and 2010. However, the Koreans have been spared the usual ravages of this transition. Given the normal limitations on the attribution of causation, one key social phenomenon stands out. School lunches are universally available in South Korea, and while initially inexpensive, were quickly offered at zero cost to the student. From the late 1990s onward, the nutritional guidelines were to preserve the traditional Korean diet, consisting essentially of vegetables, *kimchi*, and lean meats with a variety of grains, fruits, and beans. Salt, oil, and fat were not to be "overused." In a 2010 survey, 50% of South Koreans followed this traditional diet, 10% a "Western" style diet (down from 35% in 1998), and 40% a "new diet" which is similar to a Mediterranean diet.[14] This deliberate program of extolling the national tradition is presumably a major reason why the obesity epidemic has been muted in South Korea. Both government policy entities and key non-governmental organizations participated in this effort. It's not just that the diet was healthy – which was an important message – but that it was a traditional *Korean* diet that seemingly resonated with the population. Initiated with a universal school lunch program that extolled respect and appreciation of a national tradition to be revered, a nutritional pattern was established that has served the country well.

Social network targeting

While open societies allow the dispersal of ideas, fashions, and aspirations, guiding this dispersal is not a traditional component of the public health armamentarium. Social network targeting is a new and innovative concept that targets influential members of a social group with the message and allows natural community dynamics to create the widespread dispersal necessary to influence behavior. Identification of "influential" subsets is neither obvious nor straightforward and occupies a substantial part of the inaugural research effort. The work of Christakis and his colleagues has demonstrated the potential of this approach in isolated, poor, rural communities in Honduras.[15]

The methodology will require more widespread application before it can be unconditionally endorsed, but the initial studies offer great promise.

Commonalities

These five innovations have much in common: they all include multiple partners from multiple societal sectors, one of which is the government. Each program worked hard to define core goals that all participants could accept. They all included children in their formative years, although Agita São Paulo and social network programming directed their appeal to everyone, and they all had modest budgets supported by a variety of partners.

There is one other key attribute that is common to all these studies: all possess a large and important bottom-up structure. These interventions were not created by fiat; they emerged from an engaged discussion with the participants, or their parents, who then gave the support essential for carrying out the intervention. The central ingredient in Colombia, Brazil, South Korea, and Honduras was an open society. All of these attributes existed in Finland, which in this light does not now seem so remote, and nor do its results seem so categorically unattainable in less wealthy and more troubled lands.

A young woman having her blood pressure taken in the People's Republic of Bangledesh. Source: JiVitA/Sight and Life.

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The Rise of Non-Communicable Diseases (NCDs) in India

There is an unprecedented epidemic of non-communicable diseases (NCDs) in India. There were an estimated 69 million people with diabetes in 2013, and 77 million with pre-diabetes. Thus, India is regarded as one of the world's capitals of diabetes. Prevalence of coronary artery disease (CAD) is similarly high. NCDs contribute to 60% of all deaths and an estimated loss of 20 million productive life years annually.[16]

The epidemic is usually ascribed to rapid transition due to socioeconomic development. However, this is only a precipitating factor. Epidemiology of diabetes is somewhat different in Indians, who develop diabetes and CAD at a younger age and at a lower level of obesity (BMI) compared with Europeans. The rate of progression from normal glucose tolerance to pre-diabetes, and from pre-diabetes to diabetes, is faster in Indians compared with other populations; the rate at which long-term complications occur may also be faster.

These facts suggest a higher susceptibility to NCDs compared with Europeans. This could be genetic, but there is only scanty information on this. On the other hand, the heightened susceptibility can be partly ascribed to the "thin-fat" phenotype (higher body fat percent at lower BMI), which reflects in higher insulin resistance and a lower "disposition index" (B-cell function). This phenotype originates *in utero*, and is influenced by mother's small size, poor nutrition (protein and micronutrient deficiencies) and gestational hyperglycemia. Indian babies are among the smallest in the world, and low birth weight is an independent risk factor for future diabetes, coronary artery disease and related disorders. Dietary deficiency and imbalance of nutrients which regulate 1-C metabolism (vitamin B_{12}, folate and others) and maternal hyperglycemia are common amongst adolescents and pregnant women in India and have been linked with an increased risk of diabetes in the offspring. This is thought to operate through epigenetic programming, and results of trials to improve adolescent nutrition so as to reduce susceptibility in the offspring are awaited.

NCDs place a huge burden on the economy and could hamper the nation's development in coming decades. Indian diabetes prevention trials have demonstrated a reduction in progression from pre-diabetes to diabetes by simple lifestyle adjustment or a small dose of metformin. Mobile telephonic messages have also been used to promote lifestyle changes. These efforts could help curtail the escalating epidemic. India could lead the way in the "primordial" (intergenerational) prevention of the NCD epidemic.

Further reading

WHO, Burden of NCDs and their risk factors in India (Excerpted from Global Status Report on NCDs, 2014) http://www.searo.who.int/india/topics/non-communicable_diseases/ncd_situation_global_report_ncds_2014.pdf?ua=1.

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5 Challenges

The epidemiological transition to chronic, progressive, debilitating diseases was identified decades ago and has been well documented everywhere. Were it an easy problem to confront and manage, this would have been done already. There are many challenges – challenges beyond the cultural and demographic obstacles that we and others have identified. Two seem of particular relevance to nutrition-based up-stream drivers.

The first is the difficulty of engaging asymptomatic people, i.e., people who do not view themselves, or their children, as being patients or having an illness. The second is the absence of engagement in policy by the public health establishment. Achieving cost reductions or cost-effectiveness by reducing the prevalence of behavioral risk factors is only demonstrable in the long term, and the fiscal impact cannot be anticipated or budgeted for at the onset of the intervention. Other than tobacco in past generations, public health plays little role in generating or shaping public policy as it relates to health. Reacting to policy established by others is always a catch-up game, and is rarely successful.

Both in the developed and in the developing world, medical clinics are designed to treat and manage sick people. They function more like an emergency room in the United States. People go there when they or their children are sick, are in pain, or develop frightening symptoms. No-one shows up to have their blood pressure checked; no-one gives up a half day or full day in the fields or caring for the children to find out if their blood sugar level is well controlled; no-one closes the shop to get a blood draw for their annual cholesterol or glucose check, or for a mammogram. These are major barriers in the advanced, well-insured economies in which out-of-pocket expenses are eliminated; they are nearly insurmountable elsewhere. Population-based healthcare will have to go to the individual; the asymptomatic person will not go to healthcare. This barely recognized reality has yet to be converted to a widespread set of healthcare delivery policies. However, there are many innovative programs being developed, such as those that utilize mobile phones with an ever-increasing number of new technological apps for modifying nutrition or physical activity behaviors, and those that engage community health workers as the bridge to care. These approaches need to be more widely incorporated in the public health community and curriculum.

Public health needs to develop a capacity and willingness to participate in the generation and shaping of public policy that influences health. The opportunity of addressing the modifiable risk factors (such as diet) of NCDs by public policy, involving multiple public-private partners, is an exciting challenge. When the relationship between policy and health is obvious, such as the promotion of universal healthcare, public health does play a role. When subtlety is required, public health is nowhere to be found. The cautionary tale of the Trans Pacific Partnership Agreement – a trade agreement between 12 countries of the Pacific Rim, concluded on October 5, 2015 after five years of negotiations – needs to be incorporated into the public health conscience. The American public health community missed this entirely and yet it posed a huge threat to global health.[17] Agricultural subsidies are another policy area where public health has been absent, only belatedly attempting to influence aspects of its impact, such as limits or taxes on sugary beverages,[18] but not engaging in the generation of the policy itself. While it is encouraging to see now an engagement with climate change, extractive industries, chemical products such as insecticides and pollutants, and television advertising to children,[19] public health needs a much more vigorous and vigilant engagement with public policy.

Our personal view

Henry Greenberg and Richard J Deckelbaum

The planet is now in the era of the "Double Burden of Nutrition," whereby over 1 billion people are hungry and undernourished while over 2 billion are overweight or obese. Coupled with the Double Burden are the adverse effects of global warming and climate change, which lead to unexpected increases in disasters such as floods and drought. These events increase the frequency of non-seasonal, as well as seasonal, hunger and starvation. In addition to affecting many adults and children, starvation during pregnancy can lead to increases the incidence of infants with low birth weight – which in turn is a risk factor for increased risk of cardiovascular disease and other NCDs in adulthood.

There is growing evidence that severe undernutrition in pregnancy and infancy, as well as overnutrition during these periods, can have epigenetic effects which will adversely affect adult outcomes. Thus, as we have described in this chapter, while cardiovascular disease and other NCDs are "taking over" in low- and middle-income countries, investments in their prevention and treatment are only a small fraction of what is currently directed towards the more classical forms of undernutrition, e.g., maternal and child malnutrition and infectious diseases.

There are many open questions relating to the root causes of cardiovascular disease and other NCDs in developed countries. Are the root causes different in the South than in the North? Clearly, there must be much more investment in research as well as in prevention and treatment programs relating to cardiovascular disease in less developed populations.

With the decreasing contribution of infectious disease and undernutrition, we are seeing increases in life expectancies in many lower- and middle-income countries. Thus we can these NCDs to place an increasing burden on human health and economic systems in the coming decades. We need to consider the costs of *not investing in the fight against NCDs* in the 21st century. As we move into the next period of the SDGs, we should ask ourselves whether enough is invested in the attempt to counter NCDs to have the necessary impact on sustainable development.

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