Nutrition and the Epidemiologic Transition in Indonesia

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Abstract. *The process of economic development and industrialization has historically involved fundamental changes in the social and economic organization of populations. These changes are taking place today in Indonesia, and the effects are dramatic-infectious disease rates are declining, population size is increasing, and the population is growing older. Additionally, the many lifestyle changes we associate with development will also mean the rates of chronic disease will likely increase. Changing consumption patterns are the primary culprits for this transition. Increased tobacco use will cause significant increases in heart disease rates, lung cancer and many other cancers. The dietary transition towards a high fat, low fiber, high animal-food based diet that typically accompanies development will also make a significant contribution to the increased of chronic disease. The costs of the epidemiologic transition are many. The epidemiologic transition will mean a great loss of life, and many of the deaths will be premature (i.e. during the otherwise productive years of life). The direct cost of treatment for the sick will be very large. Additionally, it is not clear that the agriculture sector's response to increased demand for livestock based foods will be an environmentally or economically sustainable proposition for Indonesia.*

Keywords: Nutrition; causes of death; chronic diseases; infectious diseases; epidemiology; consumption patterns; food policy; dietary transition; infant mortality rate; Indonesia.

1. Historical Background to the Epidemiologic Transition

The history of the human species has seen only a few events that have fundamentally transformed the nature and organization of life on earth. The first such event occurred around 10,000 years ago in Mesopotamia with the advent of agriculture. Prior to this time humans had been primarily foragers and scavengers, collecting foods as they happened to find them growing naturally in the wild. With agriculture, humans took more control of the process of

producing the food they ate, and this system of direct planting and harvesting on the same ground year after year completely dominated the economic and social organization of human existence all the way down through early modern times.

The next transforming event in human history was the Industrial Revolution which in some respects we can say began in 1769 with James Watt's invention of the steam engine. Through the Industrial Revolution, for the first time in human history, it became possible for the majority of people not to be directly involved in the production or immediate acquisition of their own food. This result springs from the basic characteristic of the Industrial Revolution which is the massive increase in labor productivity through the application of machine powered technology. Labor productivity rose to such an extent over the next 150 years that it became possible for small numbers of farmers to produce enough food to feed the entire population.

Of course, such a transformation had profound affects on the organization of the social and economic relationships in society. With so few people needed to produce food, a huge amount of labor and resources was freed up for other activities. The natural consequence was the major reorganization of the economy away from agriculture and toward manufacturing. The forces acting to drive this greater productivity and increased output and therefore increased profit were mutually reinforcing so that economies grew at fantastic rates.

Out of this reorganization of productive activities came a huge increase in the wealth of the population and eventually, in the standard of living. It is the improvement of the standard of living that plays a key role in the present discussion because with an improved standard of living came fundamental changes in the consumption patterns of the population. People had more money to spend and more things on which they could spend that money. This change in economic circumstances found expression in changing consumption patterns of households, and these changes are central to the rise of new mortality patterns that emerged in the last 200 years or so in the West. We will return to consider this process shortly, but first we must consider more basic health and demographic changes brought on by the Industrial Revolution.

Coincident with the socio-economic transformation that reshaped life in populations living through an Industrial Revolution, unprecedented changes in the demographic profiles of those populations also took place. One of the first demographic changes we observe in populations undergoing this process is a drop in the mortality rate. This change has actually taken place quite recently in most Western countries, and we are not far removed at all - less than 100

years - from extremely high mortality rates in these places. In England and Wales at the turn of the century, the overall mortality rate was 18 per thousand population among males and 15 per thousand among females (Table 1). This compares to a crude death rate of 13 per thousand in 1991 for all of what the World Bank classifies as "low-income economies". For infant mortality, the situation was even worse. In 1901, the rates were 196 per thousand for boys and 156 per thousand for girls in England and Wales compared to a 1991 figure of 91 per thousand in the "low-income economies".

Table 1
DECLINE IN MORTALITY AMONG YOUNG RELATIVE TO TOTAL DECLINE, ENGLAND AND WALES, 1901 AND 1971

Age		Mortality Rate per Million 1901	1971	Difference
0-1	Male	196,282	20,254	176,028
	Female	156,601	15,137	141,464
All Ages	Male	18,160	6,405	11,755
	Female	15,832	4,435	11,397

Source: McKeown et al. 1975.

Very importantly, the biggest proportional decline in mortality rates comes in the very youngest age groups. For example, the change in mortality among the under-5 age group in England and Wales during this century accounts for 49% of the total decline in mortality (see Table 1 for comparison of decline in 0-1 age group versus all ages). This is not to say there were no reductions in the middle age ranges (15% of the total decline occurred in the 45-64 age group), but the main effect is in the early years of life (McKeown et al. 1975).

The qualitative changes in the mortality picture provide an explanation for this result. Table 2 shows the decline in death rates from various causes in England and Wales since 1901. At the beginning of this century, microorganisms (infectious diseases) were the primary killers. It is precisely here that the major declines in rates of mortality take place so that today these now form only a minor part of the overall mortality picture. At present we see non-infectious diseases as the primary killers, but while these have declined in their overall rate (from 7,612 per million to 4,536 per million) this drop is much less than the drop we observe for infectious disease, 9,346 to 848 per million. Also, the

category of non-infectious disease is in fact a diverse grouping of causes of death. For most of these non-infectious causes, we have observed a decline in their rates, but for two of them, heart disease and cancer, the rates have actually increased. We will return to these two at a later point.

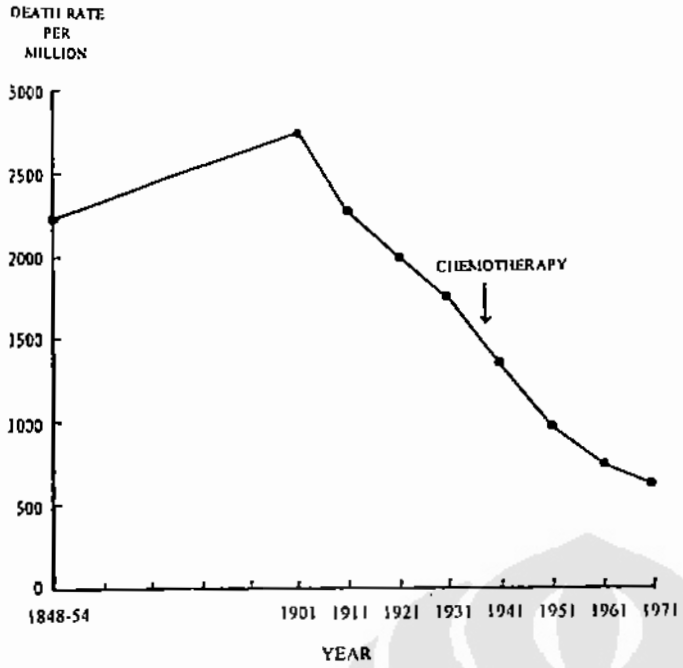
Table 2
DECLINE IN DEATH RATES FROM DIFFERENT CAUSES, ENGLAND AND WALES, 1901-1971

Cause	Rate per Million				Decline from All Causes (%)
	1901	1921	1941	1971	
Micro-Organisms:					
Air-Borne Diseases	6,000	4,227	2,748	753	45.3
Water-Borne Diseases	1,931	804	336	35	16.4
Other Conditions	1,415	648	395	60	11.7
Total	9,346	5,679	3,515	848	73.4
Other than Micro-Organisms:	7,612	5,431	6,063	4,536	26.6
All Causes:	16,958	11,110	9,578	5,384	100.0

Source: McKeown et al. 1975.

For the present, it is useful to discuss what can explain the decline in infectious disease mortality. The first place to look is obviously improved medical treatments since they seem so ubiquitous in modern life. Unfortunately, upon close inspection, we discover that in the case of almost all infectious diseases, the introduction of a vaccine or effective treatment did not arise until *after* that disease was already significantly on the decline. Not only has most of the decline in mortality rates from infectious disease occurred in this century, but most occurred *before 1935* when the earliest of the modern "miracle" medicines first appeared, and there was no acceleration in the rate of decline in those causes of death after the discovery of the treatments for them (Figure 1).

Figure 1
DEATH RATES STANDARDIZED TO THE AGE-SEX DISTRIBUTION OF THE 1901-1971 POPULATION



Note: Diseases are Bronchitis, Pneumonia and Influenza.
Source: Mckeown et al., 1975.

The real explanation lies in much more basic changes in the conditions of everyday life that shifted the balance in favor of the health of the human population and away from the spread of disease. Improvements in sanitation primarily in the form of clean water played a monumental role. Advances in the general nutritional status of the population also made a major contribution to the improved overall public health situation. With the rising standard of living that came with the economic growth generated by the Industrial Revolution came the ability to buy more food, better quality food, fresher food, and a greater variety of foods. Improvements in nutritional status have been shown to play a major role in reducing infectious disease mortality that is synergistic in its relationship to disease incidence (Pelletier et al. 1993). In other words, modest changes in nutritional status can generate very large differences in rates of mortality from infectious disease. During the late Industrial Age we saw substantial improvements in the nutritional status of the population, and these contributed a great deal to the changing mortality pattern.

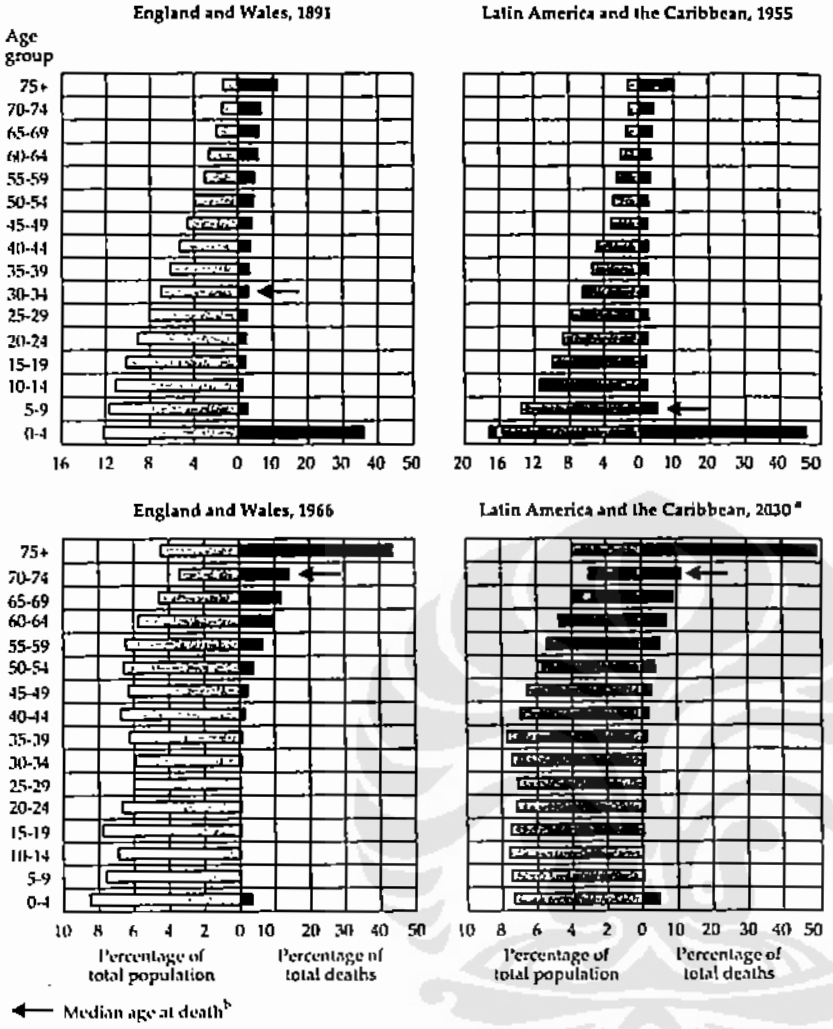
So the conclusion here must be that despite the prominence given to medical treatment in our current understanding of how to manage disease, it played a minor role at best in the huge declines in what have up until this century been the primary causes of death in humans. The real key to declining mortality rates is changes in lifestyle, a theme to which we will return when we discuss late or post-industrial mortality patterns, but there it will not generate a positive outcome.

2. The Demographic Transition

The result of this new mortality pattern is that more and more children survive into adulthood. The simple mathematics of this demographic shift mean that the relative proportion of the population made up of older people will grow with each new generation that survives into the older age groups. The traditional population pyramid (Figure 2) where the bulk of the population distribution concentrates in the younger age groups at its base becomes a population rectangle with more nearly equal numbers of people distributed across all the age groups. This process has taken place to a great extent already in most Western countries, and is rapidly under way in Indonesia today as Ananta and Arifin have demonstrated very clearly (Ananta and Arifin 1990).

It is at this point that the epidemiologic transition first comes into view. The initial proposition by Omran in 1971 was based on the observation that with the changing age structure of the population we would also see the net aging of the population as a whole. We would have many more old people and, in relative terms, many fewer young people. In such circumstances, the diseases of old age would begin to emerge as the important public health problems simply by virtue of the great number of old people. Since the diseases of old age are qualitatively different than those of young age, with many chronic diseases common in the former and infectious diseases dominating the latter, we should see an epidemiologic transition. No longer would we be living in a high infectious disease environment but would instead find ourselves in a high chronic disease environment (Omran 1971). In this way, the demographic transition, the aging of the population, would *cause* the epidemiologic transition.

Figure 2
EVOLVING PATTERNS OF AGE DISTRIBUTION AND MORTALITY IN ENGLAND AND WALES AND IN AMERICA AND CARIBBEAN



Note : a. Projected.
b. The age below which half of all death in a year occur.

Source : For England and Wales 1891: Preston, Keyfitz, and Schoen 1972; for England and Wales 1966: United Nations, *Demographic Yearbook*, 1978, for Latin America and the Caribbean 1955 and 2030: World Bank data.

In one sense, this model has great utility in explaining the forces at work to produce the epidemiologic transition, but it is also quite incomplete. It assumes a static disease environment, but as we have seen, part of what produces the demographic transition is precisely the opposite, a specific change in the disease environment. The infectious diseases that previously ravaged the young no longer constitute such a major public health issue, and as a result, more children survive to adulthood and the population ages. And what of chronic diseases? If they were to decline at the same rate as infectious diseases, then of course there would be no epidemiologic transition at all since all gains would balance each other out. On the other hand, if chronic disease rates were to go *up*, then we would see an even more pronounced epidemiologic transition. Not only would the population be older, but we would have an older population whose older segments are dying in increasing numbers from the new high rates of chronic disease.

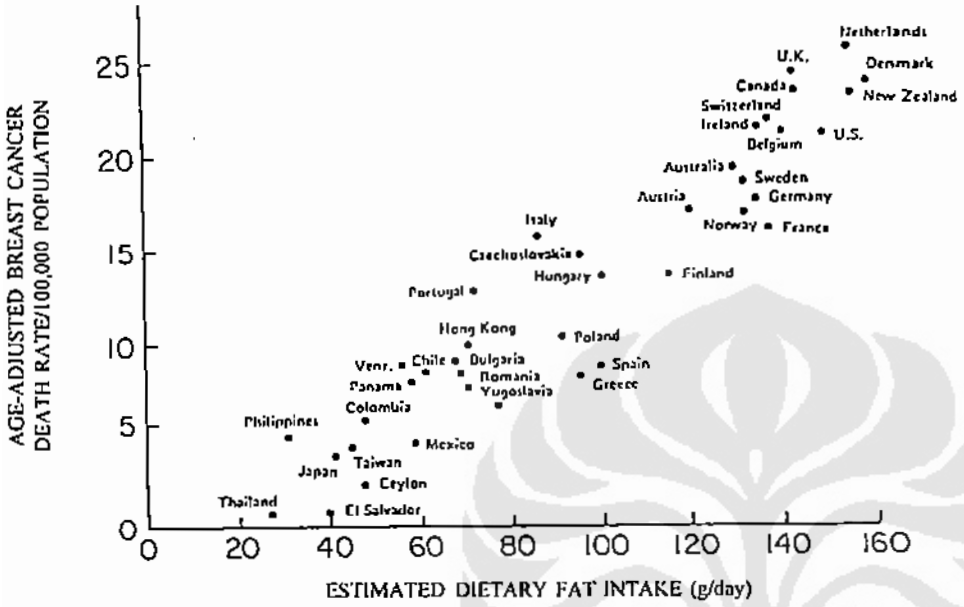
3. The Epidemiologic Transition

So the question remains, what is happening to chronic disease rates, and even more significantly, why? Clearly, chronic disease rates are not the same everywhere. The classic work done by Carroll shown in Figure 3 demonstrates this well. Carroll used an international data to compare breast cancer rates versus per capita fat disappearance in countries varying widely in terms of geography and economic development. He found a very strong positive correlation between the amount of fat in a country and the rate of breast cancer. Some countries such as Thailand and El Salvador where disappearance of fat was around 25-40 g/day/person had breast cancer mortality rates of less than one per 100,000, but countries such as the Netherlands and Denmark where fat disappearance exceeded 150 g/day/person had rates of breast cancer in the range of 24-25 (Carroll 1975). This 25 fold increase must be considered very seriously.

The point in this example is not that fat causes breast cancer (this would be an obviously inappropriate conclusion to draw from these data), but that the age-adjusted rates of the disease vary dramatically from place to place. It is not just that we see more deaths from breast cancer in the West merely as an artifact of the higher relative ages of those populations, we see more deaths from this disease within every age group. This type of variation in rates occurs for essentially every chronic disease. We could do a similar analysis if we were to look at different regions *within* single countries or across the dimension of time and would find that rates of chronic disease vary in this way as well (Chen et al.

1991; Himes 1994; Lopez 1990; McKeown et al. 1975; Slattery and Randall 1988; Uemura and Pisa 1988). The basic conclusion we can draw is that in every case where the rate of a disease is high in one place, it is low in another, and the use of age-standardized rates means this result has nothing to do with the age structure of the population.

Figure 3
CORRELATION BETWEEN PER CAPITA CONSUMPTION OF DIETARY FAT AND AGE ADJUSTED MORTALITY FROM BREAST CANCER



Note: By permission of Carroll 1975, *Cancer Research* 35: 3374-3383.

What could explain this result? Why do *rates* of chronic diseases go up in addition to just the proportion of total deaths attributable to those causes -- a result that could simply be a function of the now larger proportion of the population (old people) susceptible to those deaths? Genetic differences between populations offers an inadequate explanation. Numerous migrant studies have succeeded in dismissing this hypothesis by showing, for example, that Japanese migrants to Hawaii, within three generations and without intermarriage, display the same chronic disease profile as the local Caucasian population while the rates in Japan remained constant (Doll and Peto 1981). Therefore, if it is not genetics

that explains the differences, it must be the manner in which people live their lives.

4. Causes of the Epidemiologic Transition

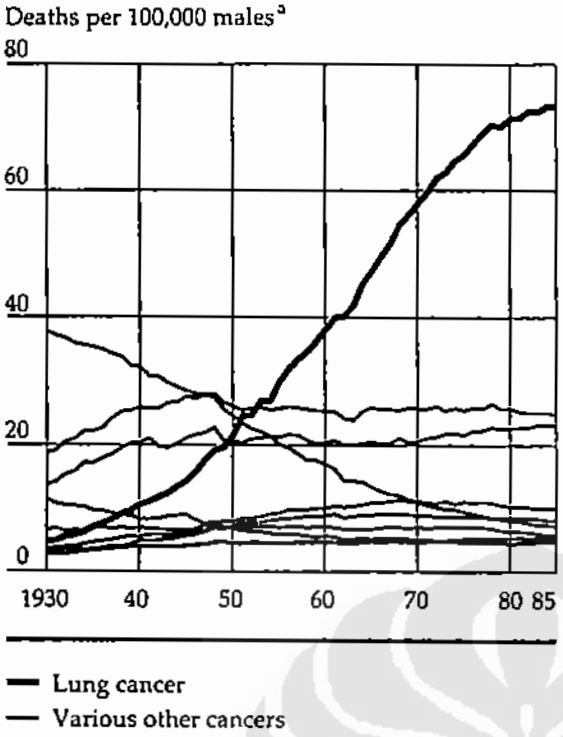
It is important to keep in mind that these chronic disease rates do not just go up incrementally; as we have seen, they are often many times the rates in low incidence countries. What is more, the deaths due to chronic disease are *premature* deaths, hitting people in the prime of their productive lives after having invested great amounts in many cases for their training and education. Also, the diseases themselves are extremely expensive (and unpleasant) to treat. All this means the transition to a new lifestyle we associate with the transition to an industrial economy has some very serious consequences. As such, it becomes vitally important to discover which of the lifestyle changes are the ones that cause so many of the ill effects listed above.

5. Tobacco

The most obvious and most strongly implicated culprit, without a doubt, is tobacco. The 1993 World Development Report warns that "tobacco related deaths from heart disease and cancers alone are likely to double by the first decade of the next century, to two million a year, and, if present smoking patterns continue, they will grow to more than 12 million a year in developing countries in the second quarter of the next century" (World Bank 1993). It must be pointed out that currently, more than two-thirds of the adult males in Indonesia smoke, and although the rates of disease are not alarmingly high at the moment, they will be in only a few years.

Smoking rates peaked in the United States in the 1950's after which time we have seen a fairly steady decline. However, the rates for lung cancer mortality, which had traditionally been rather modest compared to other cancers, continued to rise through the 1960's and 1970's before finally appearing to level off in the 1980's, some thirty years after the peak of tobacco use (Figure 4). Today, lung cancer is the number one killer among the cancers, and it is also a major reason why coronary heart disease is the number one cause of death in the United States. All this is true in a country where the rate of smoking was never much over 50%. Clearly, Indonesia has a public health disaster waiting twenty to thirty years over the horizon unless dramatic changes in smoking behavior take place in the very near future.

Figure 4
TRENDS IN MORTALITY FROM LUNG CANCER AND VARIOUS OTHER CANCERS AMONG U.S. MALES, 1930-1990



Source : World Development Report 1993.

6. Dietary Transition

But while tobacco surely merits a very high place on the list of culprits producing high rates of chronic disease in the industrial economies, it is by no means the only one or even the primary one. Of great significance is the much more complex phenomenon of dietary change, and in particular, change away from a plant food-based diet towards one that is especially focused on the consumption of animal foods.

Since 1909, the U.S. Department of Agriculture has made annual determinations of its domestic per capita consumption (based on food availability at retail level) that show major shifts in consumption patterns. In the initial year,

per capita beef consumption was 58.6 pounds. The consumption of beef then steadily increased until 1976 when it reached a high of 94.1 pounds per capita, nearly double the figure from the turn of the century. Poultry showed even more dramatic increases with per capita consumption rising from 16.3 pounds in 1909 to 89.7 pounds in 1996, nearly a six fold increase. Milk consumption shows a slightly different pattern with increases from 34.1 gallons per capita to 44.7 gallons between 1909 and 1945, but since the end of the Second World War the consumption has shown a steady decline and reached the level of 24.4 in 1995. Cheese consumption, on the other hand has shown continued sharp increases, especially since 1945. Between 1909 and 1945, the cheese consumption level remained fairly constant with some gradual movement upwards late in the period from 3.8 pounds per capita to 6.4 pounds per capita. But since 1945, this figure has risen steadily each year up to the most recent year for which we have data, 1995, in which cheese consumption reached an all time high of 27.4 pounds per capita (Putnam 1997).

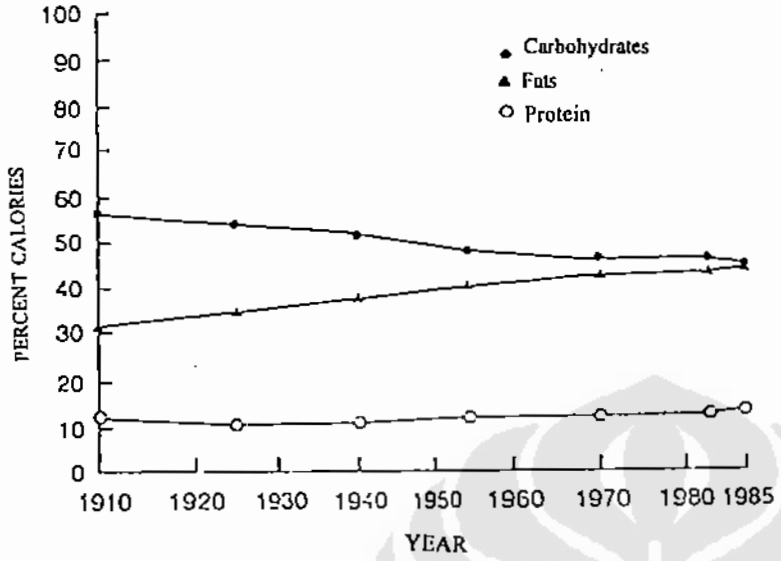
While the consumption of these animal products has gone dramatically upwards in the United States since the turn of the century, the consumption of staple grains has shown contrasting sharp declines. In 1909, Americans consumed 300 pounds per capita of flour and cereals. By 1972, this figure had dropped to 133 pounds per capita. However, the level of grain available has risen steadily since the mid 1970s so that by 1995 it was up to 192 pounds per capita (Putnam 1997).

The trend towards increased grain consumption in the last two decades marks an interesting contrast to the decrease in beef consumption over the same period. Beginning in the 1970s, public health officials have emphasized the potential harm of high fat, low fiber diets, and these changes in consumption may well reflect rising concern in the public for the long term health effects of diet.

Although these numbers represent per capita availability data rather than true consumption data, and although there have been many important changes in U.S. agriculture policy over the century that may influence these figures independent of actual consumption, the conclusion seems clear: the West has seen fundamental transformations in the patterns of diet since the beginning of this century. In the United States, since 1900 consumption of meat and dairy products has gone up dramatically while the consumption of grains has plummeted. The result has been a complete transformation in the nutrient composition of the American diet. One important aspect of the change relates to the macro-nutrient make-up of the diet where greater amounts of fat have

displaced what were once very high levels of carbohydrate consumption (Figure 5).

Figure 5
PERCENTAGE OF CALORIES FROM PROTEIN, CARBOHYDRATES, AND FAT FROM 1910-1913 TO 1985



Note: These data fail to present the entire picture, since food supply data do not include alcohol or grains used in production of alcoholic beverages.
Source: R.M. Marston, USDA/HNIS 1986 (unpublished data).

A more detailed look at the changes in nutrient profile comes from comparing U.S. mean daily dietary intakes with those from rural China (an area where traditional agricultural practices still dominate the local economy much as they did in the last century in the United States). Here we see major contrasts in fat intake (the U.S. is far higher), as well as fiber and carotenoid intake (U.S. much lower) to name a few of the many differences (Table 3). Additionally, we can see that the U.S. mean daily intake of protein is not just higher overall than in China; the American intake of *animal* protein is 10 times higher than the Chinese. In the United States, animal protein accounts for the great bulk of all protein intake while in China it makes up only slightly more than 10% of the total. The Americans (along with people living in other Western countries) have adopted a diet dominated by animal foods which is very much in contrast to the

plant-centered diets of traditional agricultural peoples everywhere and to their own diet of only 100 years ago.

Table 3
COMPARISON OF AMERICAN DIET WITH RURAL CHINESE DIET (MEAN DAILY INTAKES)

	Unit	*U.S*	*CHINA*
Total fat	% of kcal	38-40	15
Dietary fiber	g/day	10-12	33
Soluble carbohydrate	g/day	240	470
Calcium	mg/day	1140	540
Protein	g/day, 70kg male	90-95	64
Animal protein	% of total protein	70	7
Iron	mg/day	18	34
Thiamin	mg/day	1.4	2.3
Retinol	RE/day	990	30
Total carotenoids	RE/day	429	836
Vitamin C	mg/day	73	140
Riboflavin	mg/day	1.9	0.8
Energy intake	kcal/day	2360	2640

Source: Chen et al. 1991.

But how does dietary change relate to grossly elevated rates of chronic disease mortality? Should we be worried that the same process of change, were it to occur in Indonesia (and evidence suggests it is occurring), would likely lead to similar patterns of high chronic disease mortality? A substantial body of literature investigating the relationship between diet and nutrition and chronic disease can help us answer these questions.

Beginning in the 1950s investigators began to gather broadly based evidence on the issue of diet and chronic disease through such research projects as Ancel Keys' Seven Countries Study, the Framingham Heart Health Study, and the Multiple Risk Factor Intervention Trial (MRFIT) (Keys et al. 1986; Lyu et al. 1994; Stamler et al. 1986). Each of these studies provided strong evidence of the relationship between diet and the subsequent occurrence of chronic disease, and of heart disease in particular. One of the primary factors raising risk of mortality was serum cholesterol, and in these studies dietary fat intake was implicated as the chief cause of high serum cholesterol. A clear relationship had been established here between dietary practice and heart disease outcomes.

Cross-country correlation studies like the one discussed above (Figure 3) followed on from the early studies in implicating diet as a cause of cancers and heart disease. Fat certainly did seem to have a striking relationship to breast cancer rates, but then again, substituting GNP per capita as the explanatory variable would produce an even tighter relationship. Even telephone poles per capita would correlate quite well. Clearly, the problems of the ecologic fallacy limit the interpretation we can derive from these types of studies, but they were suggestive nonetheless. Suggestive enough in fact that they inspired a whole series of additional work in this area.

Other epidemiologists took up the call to investigate these relationships and have produced numerous case-control studies, several large longitudinal cohort studies such as the Nurses Health Study at Harvard University, to name a prominent example, and some intervention trials as well. The strongest conclusions from this body of work can be summed up as follows: People who eat significant quantities of meat have higher risk for many cancers, and what is more, those who eat large amounts of fresh fruits and vegetables and fiber have greatly reduced rates of cancer. Also, dietary fat and animal protein intake show a significant affect on serum lipids which in turn have been shown to be very important in heart disease as well as being correlated with many cancers, obesity, diabetes, and cerebrovascular disease.

One study of particular relevance to the current discussion is the Cornell-Oxford-China Project (Chen et al. 1991). I mention it here for two reasons. First, the results in and of themselves are extremely interesting, and second because this is one of the few studies to look at the relationship between diet and disease in a non-Western or non-industrial culture. It can be very informative as we discuss what may happen in Indonesia as its economy continues to grow. The China Project was based on a survey of adults from randomly selected villages in 65 counties in rural China with extremely comprehensive nutritional data as well as blood and urine samples collected from the study subjects. The populations groups in the project were remarkably stable with roughly 90% of the adult subjects residing in the county of their birth, and all food was locally produced in a manner consistent with traditions and practices extending back generations. These characteristics mean the study population was especially well suited to this sort of ecologic analysis.

The nutritional variables were matched with mortality data from the various counties in order to test the hypothesis that areas where the people ate plant-rich diets would show lower cancer and other chronic disease rates than those eating large quantities of foods of animal origin. This study provided a

broad ranging confirmation of the other epidemiologic results in that nutrition was a very important predictor of disease outcome.

The China Project demonstrated that even in a developing country context, complete with vastly different ranges of dietary exposures than in the West (where almost all the traditional epidemiological work had been done previously), the relationship between nutrition and chronic disease still holds. Even at very low levels of animal food intake, and with very low background rates of chronic disease, every increment in the direction of increased animal food consumption was positively associated with a corresponding increment in chronic disease rates (Campbell et al. 1992; Peto et al. 1989). The implications here are easy to grasp for a country like Indonesia, rapidly moving in the direction of greater wealth, improving standards of living, and changing lifestyles.

Finally, there is a vast abundance of research in the laboratory pointing out the importance of nutrition in the mechanisms involved in the causation of chronic disease. It will not add much to the present discussion to summarize these studies except to say there is an overwhelming abundance of complementary evidence from the laboratory showing the same strong relationships between the kinds of dietary patterns I described in epidemiologic studies and chronic disease outcomes.

It is not the purpose in this paper, however, to make this case for theories proposing a relationship between diet and cancer or chronic disease generally. A great deal of evidence exists to support this hypothesis. Numerous major reports have outlined the strong connections between diet and chronic disease (National Academy of Sciences 1982; National Research Council 1989; U.S. Surgeon General 1988), and a forthcoming report from the American Institute for Cancer Research and the World Cancer Research Fund (expected late 1997) will provide a substantial argument summarizing the most recent research in support of the relationship between diet and cancer for the first time from a truly global perspective.

For the present, there is reason to conclude that the human organism simply is not well suited to consume, digest and metabolize foods of animal origin in any significant quantity, and eating a diet rich in these foods tends to result in high risk for chronic disease mortality. As a corollary to this proposition, we can state that as populations have attained greater wealth through the process of national economic development, they have historically changed their consumption patterns in the direction of increased intakes of these animal

foods, and this has contributed in a major way to the rise of the chronic disease burden and all its consequences in these countries.

7. The Situation in Indonesia

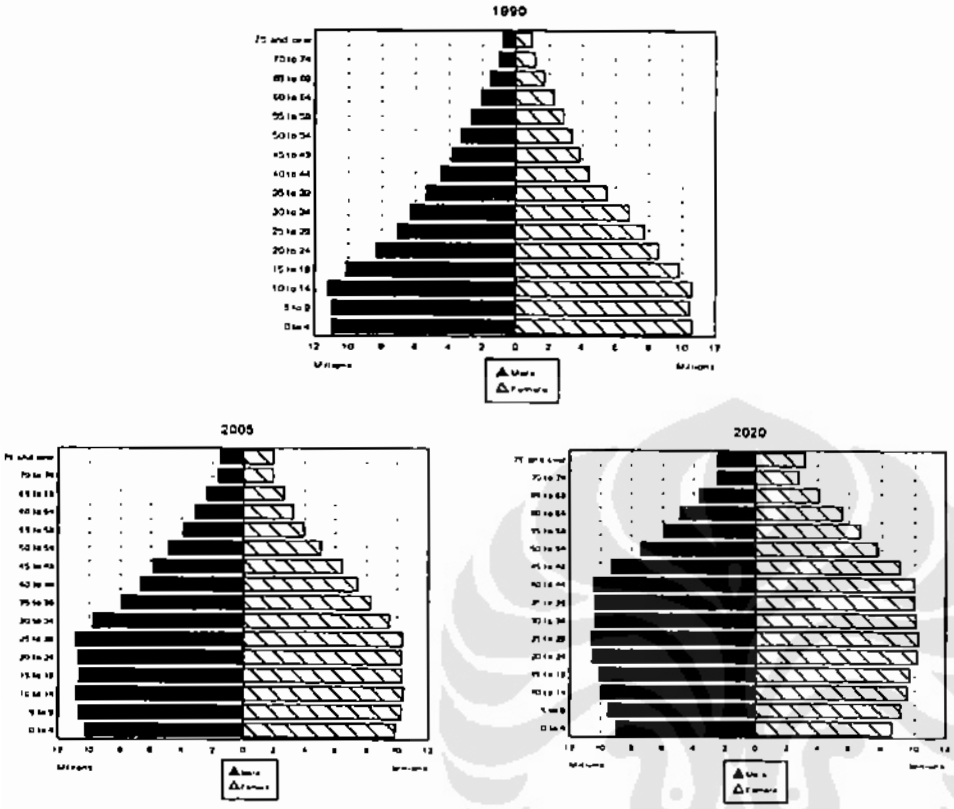
As defined in this paper, the epidemiologic transition involves socio-economic changes in a population that lead to changes in the demographic structure of the population and in changes in lifestyle, particularly nutrition behaviors. These changes result in a transition from a society characterized by high overall mortality, especially high mortality in the early years of life (infant and under 5), high rates of infectious disease mortality, and relatively low rates of chronic disease mortality to a society characterized by low overall mortality, very low mortality in the younger ages, low rates of infectious disease mortality, and much higher rates of chronic disease mortality. Let us now look at Indonesia to see where the country is today and along what trajectory it seems to be moving, at least to the degree that is possible with the currently available evidence.

In terms of socio-economic trends, there is obvious and abundant evidence that Indonesia is undergoing a period of rapid economic growth and development. The rate of growth in GDP between 1970 and 1980 was 7.2% annually, the figure for the period 1980-1991 was 5.6%, and there has been no sign of any slowdown yet. In particular, the rate of growth in sectors such as industry and manufacturing have been even more rapid (World Bank 1993). Correspondingly, the incidence of poverty has dramatically declined over this same period. Between 1976 and 1990, the total poverty rate in the country declined from 40% to 15% and the absolute number of poor people has declined from 54 to 27 million even while the population has seen significant growth (Soekirman et al. 1992).

The demographic picture has undergone a similarly dramatic transformation in the recent years. Infant mortality rates have declined from a high of 238 per thousand live births in the early 1950's to a rate of roughly 60 today (Soekirman et al. 1992). The total fertility rate has declined in a similar way to the figure of 3.3 in the late 80's and is projected to reach a level of 1.8 by the year 2020 (Ananta and Arifin 1990). Quite naturally, the combination of these factors has led to a changing age structure of the population. As discussed above, in situations where the mortality rate declines, and especially where the infant mortality rate declines so dramatically, the distribution of the population in the various age groups shifts in such a way that proportionally many more

people appear in the older categories. This phenomenon is taking place in Indonesia today, and a pictorial description of the process can be seen in Figure 6.

Figure 6
AGE-SEX DISTRIBUTION OF POPULATION: INDONESIA, 1990, 2005 AND 2020



Source: Ananta A., and Arifin, E.N 1990.

As expected from the improved socio-economic situation in the country, the patterns of consumption have also changed. The data we have on the nutrition front are not complete, but several key indicators of basic nutritional status suggest marked improvements. Total per capita calorie intake has increased from 1,947 per day in 1968-70 to 2,675 calories per day in 1986-88. It is very important to note, however, that the distribution of those calories among different major food groups has not changed substantially in that time. In other words, while people have made quantitative increases in their nutritional intakes, they

have not made major qualitative changes in the types of foods they eat as yet (Soekirman et al. 1992).

The data for mortality in Indonesia do exhibit some unfortunate limitations, but even so, we are able to discern from them the basic pattern of mortality for the country and compare it to other countries in the world. Two investigators (Soemantri and Siregar 1993) have undertaken precisely this analysis, and the results appear in Table 4. From these figures, it is clear that Indonesia, despite its rapid growth in income, and changes in the nutritional status of the population that came along with that growth, has yet to undergo the transition to the mortality patterns characteristic of industrialized countries. In looking at recent time trends in the pattern of mortality, however, it does appear that these patterns may already be changing in that direction (see Table 5). Changes in methodology between years for the surveys that produced these data, and the lack of information on rates of mortality in them, do suggest caution in their interpretation, but it does appear that infectious disease is becoming a much less important cause of death in Indonesia while circulatory diseases and neoplasms are on the rise. Thus, even if Indonesia does not yet mirror the industrialized countries in its disease profile, it may at some not too distant point in the future.

Table 4
SELECTED CAUSES OF DEATHS, INDONESIA DEVELOPING AND INDUSTRIALIZED COUNTRIES

Diseases Causing Deaths	Indonesia[1)]	Developing Countries	Industralized Countries[2)]
Infectious diseases	43.1	45.0	4.6
Circulatory Diseases	16.6	17.1	53.7
Neoplasm	4.5	6.6	20.8
Perinatal problems	7.2	8.4	0.9
Pregnancy related problem	1.8	1.3	0.0
Injury	5.0	6.3	7.0
Others	21.8	15.3	13.0
Total	100.0	100.0	100.0

Source: 1. SKRT (National HouseholdHealth Survey) 1992.
2. Mosley 1985 (Table 4).

Table 5
SELECTED CAUSES OF DEATHS IN INDONESIA
SKRT 1980, 1985/86 AND 1992

Diseases Causing Deaths	Year 1980	1985/86	1992
Infectious diseases	60.9	53.8	43.1
Circulatory diseases	9.9	9.9	16.6
Neoplasm	3.4	4.3	4.5
Perinatal problems	2.9	5.3	7.2
Pregnancy related problem	0.9	1.7	1.8
Injury	3.5	4.8	5.0
Others	18.5	20.2	21.8
Total	100.0	100.0	100.0
(N)	(905)	(2055)	(1213)

In summarizing these observations, we arrive at several conclusions. Indonesia is in the midst of a period of very rapid development; of this there is no doubt. We see manifestations of this development in many areas. For example, food security is much less of an issue than ever before in Indonesia. The country has achieved rice self-sufficiency (a major triumph of the first 25-year development plan), per capita calorie availability has reached quite good levels, and the basic nutrition needs and classical deficiencies are becoming less and less of a problem (although these are still quite serious public health concerns in significant segments of the population). Additionally, the infant mortality rate has come down with impressive rapidity, and infectious disease is causing a smaller and smaller proportion of the total deaths. This is all happening at a time of rising incomes and standards of living throughout the country. In short, Indonesia seems poised at the doorstep of the epidemiological transition. We see a country with an aging population ready to make the jump to a high-fat, high-protein, high animal food diet that we associate with rising incomes and that bears such a strong relationship to the rise in chronic diseases in a population.

One important limitation in our ability to track the epidemiological transition in Indonesia is the simple lack of data and corresponding analyses of the trends in the country. As yet, there has been no systematic investigation of the forces that might be acting to drive the dietary pattern in the direction of increased fat, protein and animal-food intakes, the consequences this will have for disease rates, and the subsequent economic and social implications of these

changes in disease rates. Any such studies will have to keep several factors in mind which I will list briefly below:

First, biological risk factors (such as nutrient intakes) often act synergistically with one another. As a specific example, the intake of polyunsaturated fat has been associated with increased cancer risk. This is a matter of great concern since polyunsaturated fat intake has also been associated with lower heart disease risk (through lowering of cholesterol levels). Will we have to trade risk of one disease for risk of another? Fortunately, the effect of polyunsaturated fat on cancer rates only results when the overall intake of fat is high (Hopkins and Carroll 1979). In other words, the net effect of polyunsaturated fat depends on the level of total fat, and this net effect can be decidedly positive (lower CHD and no increased risk of cancer) if total fat is low. In this way the level of one risk factor can determine the potency of another risk factor. And these interactions apply to all the constituent compounds in the diet meaning that raising the level of one risk factor can potentially increase the power of many, many others to influence disease outcomes.

This phenomenon becomes especially significant when we consider that broad dietary changes such as shifts from plant-based to animal-based foods involve dramatic changes in the levels of huge numbers of nutrients and so-called non-nutritive food components, and a great number of these factors contribute to the causation of a whole variety of diseases. Dietary change implies a potentially very large amplification of the role of diet beyond the simple additive effects of single nutrients taken individually.

Second, there will be time-lagged effects of dietary change. While some changes in dietary practice may make immediate contributions to the ultimate occurrence of disease, chronic diseases arise from a multistage process with many events in the causal pathway taking place years or even decades before symptoms first appear. The extent to which diet plays a role in these events, which occur at different points in the series of events leading to ultimate disease, will determine how much time we would need to wait before we see the full effect of dietary change on disease incidence. In this way, short term investigations of the impact that animal food-based diets will have on disease profiles will very likely underestimate the true impact.

Finally, while simply investigating the biological relationships between dietary patterns and chronic disease outcomes will certainly provide valuable information, it would also be highly interesting to have information on the factors that affect the shift towards behaviors that increase the risk for disease.

Specifically, we would like to know predictors of consumption. Fortunately, Indonesia does have very good data on prices of the relevant commodities as well as on household income and consumption. Using this information we can begin to ask questions about how changes in prices might affect patterns of consumption and therefore the subsequent pattern of disease. In this way, we could illuminate policy considerations that may help address the problem of how to minimize the impact of changing lifestyle patterns associated with increased risk for chronic disease.

8. The Costs of the Epidemiologic Transition

There are several broader issues that suggest just how significant the impact of the changes in dietary patterns can be. The significant increase in chronic disease rates we associate with a change to a high-fat, high-protein, high animal-food diet is itself sufficient justification to take this matter seriously; the increased rates of mortality could be dramatic. But the impacts of this lifestyle change only begin with this large-scale loss of life. A great proportion of these deaths will be what we may label as "premature deaths," that is deaths to people who are still in the most productive years of life which would normally be characterized by good health and vigor. Chris Murray and Alan Lopez have developed a method for measuring the global burden of disease based on "Disability Life Years Lost" that would have particular usefulness in this context (Murray and Lopez 1996). This method will enable us to gauge the impact of increasing rates of chronic disease on the loss of life of people who otherwise would still be productively engaged in the activities of society. Losses to the community would include at the very least the income they would have earned had they remained alive, which represents the contribution of goods and services they would have made to the economy. This is not exactly an "opportunity cost," but it does represent some of the foregone benefit to society.

9. Health Care

An even more immediate cost of the increased chronic disease resulting from changing lifestyle and dietary pattern will be the direct cost of treatment for the additional cases of chronic disease such changes will likely generate. Chronic diseases are notoriously expensive to treat. They require huge investments in acute care infrastructure. An epidemic of chronic diseases will place the health care budget of the country under enormous strain.

Evidence of the potential impact of such a burden comes from the United States where treating these diseases is far and away the major reason why health care now consumes 12.7% of the national GDP compared to 2.0% in Indonesia (World Bank 1993). Such a massive diversion of funds into the health care sector to treat these diseases has obvious negative consequences for the growth of the rest of the economy which must pay the cost. For Indonesia, the problem will be especially difficult because the rates of infectious disease, while falling, are nonetheless by no means insignificant, and the country may very well find itself suffering under the dual burden of continuing high infectious disease mortality and rapidly rising chronic disease mortality.

10. Agriculture, Environment and Sustainable Development

The change in dietary patterns toward an animal food-based diet will not only push the mortality profile in the direction we have discussed above; it will also pull the agricultural system in the direction of greater animal food production. This is not surprising as it is in the obvious interest of agricultural producers to supply what the market wants.

Expanded production of animal foods on a mass scale, especially if using intensive methods common in current industrialized agriculture, will place increasing demands upon the agricultural sector and upon the environment (soil, water and forest resources). However, in a country like Indonesia which is already densely populated in some parts (notably Java), there is little room to expand production. It takes several times more area to produce nutrients from animal sources through mass-production, feed-grain centered methods compared to nutrition directly from plants.

David Pimentel of Cornell University estimates that 29,000 kcals must be expended along the food chain (i.e., this equivalent energy value of feed grains is required for all inputs including transport, preparation of the land, and the feed grains themselves) to bring 375 kcals of beef to the table. O'Brien has calculated food conversion factors indicating it may take more than 7 or 8 units of grain to produce a single unit of beef defined in comparable nutritional terms. Such considerations raise questions about the long-term sustainability of such agricultural practices (Gussow and Clancy 1986; O'Brien 1995).

One possible strategy for meeting this need of expanded agricultural area for mass-production of animal foods would be to raise the animals and grow feed

grains in the less densely populated areas of Indonesia's outer islands, but it is not clear these lands are well suited for such production. Experience in other countries suggests this sort of agriculture can degrade the environment through overgrazing of forested areas (Gussow 1995; Pimentel et al. 1994).

The environmental impacts of mass-production animal agriculture should not be confused with the role of livestock in traditional agricultural systems. In these contexts, livestock provides many benefits to the household including the conversion of materials not usable by humans (crop wastes, kitchen scraps, cellulosic grass, and shrubs) into draft power, fertilizer, a small portion of their food, and capital assets (the animals themselves). All of these benefits actually result in the greater productivity of the farms than would be possible without the livestock.

The important distinction is that such livestock is not the primary end of these agriculturalists. The livestock in traditional agriculture is one integrated part of the whole farming system whose primary outputs are plant foods while in mass-production agriculture, all activity is directed at the production of livestock-based foods. As a result, the traditional agricultural practices do not generate nearly the livestock output that industrial farms do (Gussow 1994; Gussow 1995; Gussow and Clancy 1986). Consequently, maintaining traditional livestock practices can contribute to sustainability and also to improved nutrition and standards of living among poorer households. But such a development strategy is quite different from shifting production systems to large-scale animal production in order to meet the demands of Western-style dietary patterns.

What is more, it is by no means clear that Indonesia will be able to sustain large-scale livestock-based agriculture from a purely economic point of view. As discussed above, mass-production agriculture based on grain-fed livestock requires a great deal of land. Beyond questions of sustainability, Indonesia will need to consider whether the land exists to grow the grain needed to feed the cows that will need to be raised if the population switches by any significant degree in the direction of an animal food-based diet.

If it cannot produce this grain domestically, Indonesia will find itself in the position of dependence on imported feed grains, certainly not a desirable situation. Even if it may appear that foreign exchange is being put to its most valuable use if it is meeting high market demand for animal products, such an assessment would not be taking into account the health and foregone income costs that will result from higher rates of chronic disease associated with increased consumption of animal products. So in societal terms it would not be

as profitable to use foreign exchange this way as unadjusted market prices might suggest.

Taking into account these various considerations, does it still make sense even from an agricultural point of view (considering both the economic and environmental aspects of agriculture) to encourage the consumption of this so-called "Westernized" diet?

11. Policy Implications

Clearly, the government has a potentially critical role to play in shaping the course of the epidemiologic transition in Indonesia. All of the above are outcomes the government must consider very seriously when making agriculture and public health policy decisions. Further research in this area will help provide the government with the type of information it needs to formulate the kinds of policies that will contribute to the long term health and prosperity of its citizens. The role of the government cannot and should not be total, however. The government cannot simply dictate consumption patterns to its citizens, and it cannot legislate tastes and preferences. But there are some important avenues the government can pursue.

First, the government can make sure the citizens have the best possible information readily available to them so they can make informed decisions about the health consequences of their lifestyle choices. This involves government support and encouragement of knowledge-generating activities in this area. Equally importantly, it involves the dissemination of this knowledge through well-targeted and well-designed public education programs. Indonesia has a good record in this regard with other public health initiatives such as the family planning effort. What is needed in this case is for the government to establish the promotion of sound dietary choices for long-term good health and lives free of chronic disease as a public health priority, and then the government must act on that priority.

Second, the government can determine not to subsidize maladaptive lifestyles. In other words, the government can choose not to provide active support for the development of a livestock industry in Indonesia. Consumer demand is already driving this development all by itself; it needs no further encouragement. The government could resist the temptation to make it easier for its citizens to engage in behaviors that are against the interests of their long-term health and the public good. The short-term appearance of profitability in the

livestock sector must be weighed against the long-term negative public health consequences which can be predicted to result.

The third area in which the government may take effective action would be, conversely, to make it easier for the public to engage in healthy behaviors. One component of this strategy will be to remove any market distortions and price disincentives that work against healthier foods. For example, if price policies exist that make fatty meats relatively inexpensive compared to less fatty foods, which may actually be more highly desired than these meats, one will see consumers choose the less healthy food simply as a matter of economic rationality rather than taste preference or health consciousness. Such situations have existed in places like China where price policy made fatty pork more economically attractive than low-fat chicken, the more highly desired food in terms of taste preference (Shen and Habicht 1991). Clearly this was not the result health planners - or the consumer - desired. To take a more proactive stand, the government could provide support for the development of sectors of the agricultural economy that produce foods of undisputed health value and great appeal to the consumer. The leading examples in this category are fruits and vegetables. Through research and development for agricultural practices, investment in necessary infrastructure, and price policies, the government can make an important contribution to the increased consumption of these highly nutritious and highly valued foods.

Finally, the government can consider the reasonableness of asking those who do decide to engage in what have been identified as undesirable behaviors to assume at least part of the burden of paying for their consequences. Some sort of taxation scheme directed at the consumption of such foods as beef or pork or high-fat baked goods might serve both to discourage consumption of these foods implicated in the rising burden of chronic disease Indonesia is likely to experience in the next 10-20 years and beyond, and to help provide a source of revenue for paying the increasing health care costs associated with the consumption of these foods. This sort of policy would be analogous to the taxes many countries already place on such items as cigarettes and alcohol.

12. Concluding Remarks

The growth and development Indonesia has seen in the last 30 years in all sectors of its society have truly been remarkable. Economic activity is rapidly expanding across the board; poverty is declining in both relative proportions and absolute numbers to quite low levels; and incomes and standards

of living continue to grow at rapid rates. While these changes have brought with them many undisputed and welcome benefits, not all of the consequences of growth are always desirable. Increased crowding in major urban areas and pollution are two examples of unwelcome by products of the changes that have taken place in Indonesia over the last generation. Another byproduct of the rising incomes is the shift to the consumption of what were previously luxury goods, now affordable for the first time. Central to this shift in consumption towards luxury goods is the move toward the increasing purchase of animal foods in what was previously a country where a plant-based diet dominated.

In Indonesia today, this process of dietary change appears to be just beginning. Nonetheless, experience in other rapidly developing countries (like China) suggests that the consequences of such a shift in dietary behavior may have profound effects on the epidemiologic profile of the country. As infectious disease diminishes in importance and the new lifestyle patterns emerge, the old disease profile will be replaced by one characterized by high rates of heart disease, cancer, diabetes and stroke. The well-educated, high-income segments of the population that make the transition to the new dietary pattern first will suffer most acutely from the new epidemic of chronic disease. The direct costs of treatment of these disease will be enormous; the lost productivity due to premature death and disability at young ages will be correspondingly large. Already, deaths from circulatory diseases are the number one killer in Indonesia. There is evidence that cancer may be on the rise as well. And all this is true before major changes in dietary patterns have really taken hold.

The above is a grim scenario, but it is not the only potential outcome. Indonesia need not resign itself to this fate. A more rich and nutritionally varied diet can be composed of foods that do not contribute to chronic diseases, but in fact promote long-term good health instead. A diet rich in fruits, vegetables and grains, foods Indonesia is well suited to produce, can make desirable additions to the diet in terms of taste and enjoyment while providing simultaneous benefits for health. Dietary change in this direction, as opposed to change in the direction of a high-fat, high-protein, high animal-food diet, must be viewed as a more attractive alternative. Looking in this new direction can provide Indonesia a way forward without the unfortunate and unintended consequences that would result from repeating the dietary misadventures of the West.

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