Health status differs markedly among individuals within a given population. Yet, it does not necessarily follow that the factors which determine the health status of large populations are the same as the factors which operate at the individual level. In recent years we have come to understand how the health of the population as a whole is influenced by social/economic conditions and the "psychosocial" environment on the one hand (termed SEP conditions here), and by experiences during sensitive periods early in human development, on the other. The complex relationship between the unfolding life course and SEP conditions in a given society turns out to have a powerful determining effect on human health.

Emergence of the "flat of the health-wealth curve"

The role of SEP conditions is highlighted by the relationship between health and wealth in different countries over time. In general terms, international differences in per capita income (a measure of wealth) appear to be closely and positively related to the length and the healthfulness of life. Early in this century the relationship was simple: life expectancy was greater in countries with higher per capita incomes. Figure 1 shows that the longest lived and richest country had a life expectancy of approximately 54 years.1 However, in recent decades the relationship between health and wealth has become more complex as rich nations have grown increasingly rich. By 1990, the world's richest nations had achieved levels of national wealth unprecedented in history. At the same time, a distinct "flat of the health-wealth curve" had emerged, such that increasing income among those countries with per capita incomes greater than $10,000 US was no longer associated with further increases in life expectancy.1 Yet, the traditional monotonic relationship between health and wealth persisted among the world's poorer countries.

Why does the health-wealth curve flatten at the wealthy end? A closer look at the trends helps to answer this question. Among the Organization for Economic Co-operation and Development (OECD) countries, which make up virtually all of the countries on the flat of the curve, increases in per capita income from 1970 to 1990 did not correlate with increases in life expectancy. In other words, not only has the "one point in time" relationship between health and wealth broken down among wealthy countries, but the time sequence of increasing health accompanying increasing wealth over time has broken down, too. This does not mean, however, that all the world's wealthy countries have similar health status to one another. In fact, there are large variations in health status among them and, also, there are large differences in the rate of increase in health status over time.

Why does health status differ among wealthy countries? Useful insights into this question come from investigators who have scrutinized health and income distribution in wealthy societies2-5 and between U.S. states.4 They have shown that the propor-
tion of national income being received by the least well off families (after taxes and transfers) in each country is a strong positive correlate of life expectancy differences between them. Those countries with relatively equitable income distribution are healthier than those with relatively unequal distributions. Furthermore, those countries which were able to preserve or increase their level of income equality during the 1970s and 1980s enjoyed greater gains in life expectancy than those countries with increasingly unequal income distributions. Wealthy countries with the largest income gap from richest to poorest do show improvements in health status over time, but their gains are smaller than among wealthy countries with narrower income distributions.

**Socioeconomic gradients in health status**

Why does health status vary between wealthy countries with different levels of income equality? No-one has a precise answer to this question, but it is clear that it has something to do with the way in which different societies handle the tendency for market forces to produce social inequalities and reinforce social hierarchies. There is an important observation that health status increases with increasing socioeconomic status in every wealthy society on earth. The pattern is not, typically, a simple difference between the healthy rich and the unhealthy poor. Rather, the health status of each class within the population seems to be better than the classes below and worse than the classes above. In other words, middle class people may live longer and healthier lives than the poor, as we would expect, but they also live shorter, less healthy lives than the rich. The pattern just described is remarkably consistent across OECD countries, regardless of whether the classes are defined by levels of income, education, or occupation; so much so that it has been canonized as the “socioeconomic gradient” in health status. Furthermore, differences in the magnitude of the socioeconomic gradient in health status within each country underlie the difference in average health status between them.

The socioeconomic gradient in health status is not new. It has remained largely unchanged since the beginning of the twentieth century, despite the fact that the principal causes of death have changed completely. In fact the socioeconomic gradient in health status seems to be able to replicate itself on the principal diseases of each era. For instance, at the turn of the century the gradient was found among the infectious diseases which were the principal causes of death at the time. By late in the century, the socioeconomic gradient had replicated itself in heart disease, injuries, and almost all prevalent cancers—the current major causes of death.

With respect to health it has long been accepted that national economic factors...
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mattered, and the question has always been, how much? But the belief was that economic factors operated through the consumption of items affecting health, such as food, housing, and medical care. The debate seemed to end with the notion that, beyond a certain level of individual income necessary to buy healthful goods and services, no more health gains could be expected from increasing prosperity. It is now clear that there is much more at stake, and that the socioeconomic effect is not confined to those too poor to buy health-enhancing goods. Rather, the socioeconomic gradient emerges from a complex mixture of psychosocial and material influences operating at various levels of social aggregation and, also, a series of biological responses whose character and significance varies from stage to stage over the life course.

A model of these relationships is presented in Figure 2, which represents the individual life course as an arrow piercing a bull’s eye, which represents society. Society is shown to have three classes of factors (the three concentric circles) which represent determinants of health and well-being at three levels of social aggregation. At the most intimate level are the factors associated with social support. At the next level out are the factors at the level of the civil society which can buffer or exacerbate the stresses of daily living. Finally, at the broadest level of aggregation are state factors: in particular, national wealth, income distribution, and the structure of opportunity created by history, geography, and fortune, which support or undermine health and well-being.

The picture which emerges is of a lifelong interaction between the coping skills and capabilities of the developing individual and SEP conditions as they present themselves at the intimate, civic, and state level. The dimension of human development emerges as one of the principal components of the SEP conditions which determine health throughout the life cycle.

Biologic embedding, latency and pathways

Spending one’s early years in an unstimulating, emotionally and physically unsupportive environment will affect brain development in adverse ways, and lead to cognitive and socioemotional delays. The problems that children so affected will display early in school will lead them to experience much more acute and chronic stress than others, which will have both physiologic and life course consequences. Because the central nervous system, which is the centre of human consciousness, “talks” to the immune, hormone, and clotting systems, systematic differences in the experience of life will increase or decrease levels of resistance to disease. This will change the long-term function of vital organs of the body and lead to socioeconomic differentials in morbidity and mortality. This process, whereby human experience affects the healthfulness of life across the life cycle, is called “biological embedding.”

Insights into biological embedding come from a variety of sources, including primary studies, studies of critical periods in brain development, and the emergent fields of psychoneuroimmunology and psychoneuroendocrinology. For instance, the observation that the neurological system can talk to the immune and endocrine systems supports the notion that the conditions of life, filtered through a perceptual screen, could affect the length and healthfulness of life through a wide variety of biological pathways. From the perspective of modern medicine this is more than just a little bit counterintuitive, because it challenges the importance of tackling health problems on a disease-by-disease basis.

Consider dementia of the Alzheimer’s type (DAT) as an example of how the population health perspective can transform our view of an “organic” condition. The example relates to the role of education in early life and the development of DAT in late life. When it first emerged that better-educated people scored better on the screening mental status exam for DAT, the response of biomedical traditionalists was to presume that people who are better educated are better test-takers, and can ‘fool’ screening tests. If one did a full Alzheimer’s diagnosis, they argued, this pattern of lower risk among the better educated would disappear. This objection has since been put to rest. The Canadian Study of Health and Aging showed that there was a fourfold increase of risk for “fully diagnosed” DAT from most to least educated. Other studies have produced consistent results. In addition, several longitudinal studies have shown that late in life mental status declines faster among those with lower levels of education than among those with higher levels of education.

Learning and memory depend upon connections between nerve cells in various parts of the brain. Dementia involves the loss and disorganization of these connections. Education likely enriches the network of interconnections, creating reserve capacity which can compensate for the inevitable losses which occur with aging, and postpone the onset of dementia. What is begged by observations like this is an understanding of how differing SEP conditions, unfolding over time, initiate and sustain processes which lead to differing levels of health, well-being, and competence across the life cycle. A developmental perspective which begins at the very beginning of life would seem indispensable here. In practice, this means paying particularly close attention to insights gleaned from longitudinal studies, especially those which begin at birth and follow large population samples for decades into the future.

Two different, and sometimes conflicting, explanatory models emerge of the impact of childhood experiences in later life. The first, called the “latency” model, emphasizes the prospect that SEP conditions very early in life will have a strong effect later in life, independent of intervening experience. The second, called the “pathways” model, emphasizes the cumulative effect of life events and the ongoing importance of SEP conditions throughout the life cycle. The empirical relationship between latent effects, pathway effects, cumulating risk, and a putative “outcome” (arbitrarily occurring at age 35) are presented graphically in Figure 3.

Latency Model

The essence of the latency model can be illustrated with an example from animal research. A series of studies has been carried out which examined the lifelong impact of “handling” newborn rats. Handling involves removing the mother from the litter, placing individual pups into a new cage for 15 minutes, then returning both mother and pups to their
cage. This is done once per day for the first three weeks of life. When compared to nonhandled pups, this simple intervention improved the function of the “stress system” throughout the life course. The total lifetime exposure to “corticosterone” is lowered, which is toxic to nerve cells in a brain structure known as the “hippocampus.” Cognitive functions are sensitive to relatively small degrees of hippocampal damage, so that by 24 months of age (elderly by rat standards), the handled rats had been spared some of the cognitive deterioration typical of aging. The significance of this was demonstrated by experiments which showed that nonhandled rats’ ability to learn declined with age, whereas no deterioration occurred in aged handled rats. Most relevant in this context is the final observation: the protective effect on learning could not be induced by carrying out the handling manoeuvre at a later age.14

This example clearly illustrates the notion of a critical period in development. Its essence is an opportunity to develop a competence which occurs at a discrete and unique time in (early) life and has a lifelong impact on well-being, independent of intervening experience. For instance, the risk of death from heart disease in the fifth decade of life is strongly associated with the size of an individual’s placenta at birth and weight gain during the first year of life.15-21 Certain early childhood stimulation programs have been effective in improving the life trajectories of disadvantaged children,24,25 even without any attempt to provide them with ongoing support. The common theme here is the notion of a discrete time, early in life, when the right things must happen, or else it is ‘all over.’

Pathways Model

The hypothesis underlying the pathways model is that, over time, less than optimal development, chronic stress and its physiological impacts, a sense of powerlessness and alienation, and a dysfunctional social support network will create a vicious cycle with short-term implications for educational attainment, criminality, drug use, and teen pregnancy; and long-term implications for the quality of working life, social support, chronic disease in mid life, and accelerated aging in late life. It is most closely associated with the findings from long-term follow-up studies of newborns, adolescents, working populations, and the elderly. These studies can be put together in a time sequence to reconstruct the life course. A pattern emerges which highlights the enduring impact of status and socioeconomic conditions on health, well-being, and competence from cradle to grave. In highly abbreviated form, it goes something like this:

Status differences at birth are associated with different levels of stability and security in early childhood which, in turn, affect the child’s readiness for schooling.26 Lack of school readiness leads to an increased risk of behavioural problems in school and, also, to school failure.27 Behavioural problems and failure in school lead to low levels of mental well-being in early adulthood.28 Meanwhile, the status of one’s parents helps to determine the community where one grows up, which, by the early school years, starts to influence the child’s life chances through the social networks, community values, and opportunities which present themselves.29

By early adulthood individuals start to define their own status. Already, differences begin to emerge wherein those who are doing better report higher levels of well-being. As adulthood unfolds, lower status individuals tend to end up in jobs which offer low levels of control of the pace and character of the work.30 By the fifth decade of life, those who are stuck in such jobs first develop high rates of disability and absenteeism31,32 and then they begin to die prematurely, and from the full range of major causes of death.33 This general pattern, which is more pronounced among those who are also socially isolated, persists into the eighth decade of life.34

At first glance, it would appear commonsensical to view the latency and pathway models as complementary to one another. After all, there is no reason to suppose that latent factors only act independently, because any early life event which could exert a latent effect could also be the first step along a lifelong pathway which might have implications for health, well-being, or competence in the future. Conversely, any early childhood intervention designed to improve health and well-being in the long run will occur within a specific context which will provide a mixture of opportunities and barriers. Indeed, the closer the correlation between early life
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Despite the conceptual complementarity, the two approaches end up in ideological conflict. The latency model, on the one hand, leads easily to a ‘vaccination’ approach to policy, through the following reasoning: the more important that critical periods are, the more important latent effects are. The more important latent effects are, the more important targeted strategies for child stimulation and social support are, at critical periods in the development of the human brain.

According to this approach, socioeconomic influences on health, well-being, and competence throughout the life cycle ought to be addressed through a series of magic bullet type social, emotional, and/or educational strategies: highly focussed in time and very specific in content. Deeper challenges to the nature of society can be blissfully ignored. The pathways model, on the other hand, leads directly to the prying open of social policy questions from cradle to grave and the pursuit of a broad agenda of social reform.

From individual to society

The model of biological embedding would predict that, if childhood interventions were to improve health and well-being throughout the life cycle, and fundamentally address the socioeconomic gradient in health status, they would be more likely to be social or educational interventions than health interventions per se. The body of evidence which can be derived from intervention studies in the early childhood and preschool period suggests that performance in two basic domains of child development, the cognitive and the social-emotional, can be modified in ways which should improve long-term outcomes. Moreover, evidence from such long-term follow-up studies as we have strongly support the view that they do improve long-term outcomes.

But can the effects of individual intervention studies be scaled up to improve society as a whole? This question is motivated by comparison between Sweden, Canada, and the United States, which defined a very large ‘potential space’ for improvement in competence in Canada and the U.S. Table I compares the level of literacy and numeracy among the least-well-educated segments of the Swedish, Canadian, and American populations. Sweden is a high-life-expectancy OECD country with a shallow socioeconomic gradient in health status and a high level of income equality. Canada is a moderately high life expectancy country with a steeper socioeconomic gradient in health status and an intermediate level of income equality. The United States is a low-life-expectancy country with a steep socioeconomic gradient in health status and a low level of income equity. In addition, both Canada and the United States tolerate much higher levels of child poverty than anywhere in Western Europe. The table shows that literacy and numeracy skills, even among the least-educated parts of Swedish society, are substantially better than in Canada or the United States.

This conjunction of levels of competence, health, and income equality is central to the relationship between population health and human development in wealthy societies. As an exercise in international comparison, the differences found could not necessarily be construed as being due to differences in child stimulation regimes, or any other specific factor for that matter. Factors at all levels of society may have played a role. The problem of scale begs a deeper understanding of the dynamics of health, well-being, and competence in society.

REFERENCES


| TABLE I
Percentage of Adults with Primary Education Only Who are at Each Level of Proficiency

<table>
<thead>
<tr>
<th>Literacy Scale</th>
<th>Numeracy Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest</td>
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</tr>
<tr>
<td>Canada</td>
<td>73.6</td>
</tr>
<tr>
<td>U.S.</td>
<td>74.0</td>
</tr>
<tr>
<td>Sweden</td>
<td>22.5</td>
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</tbody>
</table>

Source: Adapted from OECD, Statistics Canada, 1995

events and subsequent lifelong pathways, the more difficult the statistical problem of estimating the partial contribution of each.

Consider, for example, the findings of the longitudinal follow-up of subjects from the Perry Preschool Study, to age 27 (Figure 3). This study is significant because it was based upon one of the most comprehensive of the early intervention programs for children in American inner cities and because it was evaluated by comparing outcomes among children who were randomly assigned to “preschool” and “no preschool” groups. The data can be interpreted two ways. One interpretation would emphasize the remarkable improvements experienced by the preschool group in relation to the controls: higher rates of high school graduation, higher earnings, a higher proportion of home ownership, less use of social services, and much lower arrest rates. The alternate viewpoint would emphasize the fact that most of the achievements of the preschool group, although impressive when compared with the controls, do not nearly match those of middle-class children who have been presented with better opportunities but no special preschool intervention programs. After all, 7% of the intervention group had still been arrested or detained at least five times and 59% had received social services in the 10 years prior to follow-up.

At first, this example seems to illustrate the complementary nature of the power of latency, as demonstrated by the elements of effectiveness of the targeted “early life” intervention, and the power of the pathway, as demonstrated by the strict limitations to success which existed in the specific context of the study community. Yet despite the conceptual complementarity, the more difficult the statistical problem of estimating the partial contribution of each.


