The demand for health and health concerns after 30 years
Arleen A. Leibowitz*

UCLA School of Public Policy and Social Research, Los Angeles, CA 90095-1656, USA
Available online 28 July 2004

Abstract

Michael Grossman’s seminal model stressed that health production requires both goods and time. Yet recent empirical health research focuses primarily on personal medical care to the exclusion of other inputs to health. Future research should place greater emphasis on the roles of non-medical consumption goods, population level inputs and time in producing health capital. Improved information technology will allow researchers to dissect how education promotes efficiency in combining goods and time to produce health. Economic analyses of child health, which is the antecedent of adult health, must proceed in tandem with medical advances in understanding health development in childhood.

JEL classification: I12; I11; I15

Keywords: Health; Demand; Grossman model; Insurance; Medical services

1. Introduction

It has been 30 years since Michael Grossman’s influential book, ‘The Demand for Health: a Theoretical and Empirical Investigation’ (Grossman, 1972) revolutionized the economic analysis of health. Grossman drew a clear distinction between health and medical care services, building on the insight that consumers combine their own time with medical services to create the commodity health. Using the key concept of home production elaborated in Gary Becker’s seminal work, ‘A Theory of the Allocation of Time’ (Becker, 1965), Grossman tailored the model to suit the health care case by incorporating an investment motive in addition to the consumption motive.

* Tel.: +1 310 206 8653.
E-mail address: arleen@ucla.edu (A.A. Leibowitz).

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Treated health as endogenous was a major difference between the “Grossman model” and the health models that preceded it. Previous analyses of the demand for medical care are characterized by an insurance-like view of health: bad health occurs stochastically and medical services are used to repair the damage if an accident or illness does occur. In contrast, in the Grossman model, individuals weigh the costs and benefits of investments in health to determine how much of a stochastic loss to offset.

Grossman’s model featured an important role for time. He took the “flow of healthy days” as the desired outcome and allowed for the shadow price of one’s own time in producing health as a major input cost. A second major contribution was to treat education as a factor that increased one’s efficiency in producing health and reducing the shadow price of investment at any given age.

Section 2 of this paper incorporates the effect of non-medical uses of time on health, the role of community-level inputs on health and the role of investments in health development in childhood into the basic Grossman model. Section 3 examines recent empirical evidence on the role of education in increasing the efficiency of health production. Sections 4–6 address the allocation of time to non-medical uses, community-level factors and health development over the life cycle. The paper concludes with a discussion of the implications of the expanded model for research to increase understanding of the health challenges of the 21st century.

2. An expanded health production model

The Grossman model considered an intertemporal utility function where utility depends on both the flow of healthy days \( (h_t) \) from a stock of health available in a given period, \( (H_t) \) and on the consumption of other commodities, which are produced at home by combining purchased market goods and time. The model in ‘The demand for health’ considered the change in health stock in any period to be the net result of gross investments in health and the depreciation in health stocks that occurs with age. Consumers were viewed as producing gross investments in health using inputs of medical care and their own time. Greater stocks of human capital were conceptualized as improving the technology of health capital production, that is, yielding greater health outputs for given levels of time and medical inputs.

In view of the literature that has developed in the intervening 30 years on the effects of health habits on an individual’s health, it is important to incorporate into the health production model the role of non-medical consumption. Not only do non-medical commodities compete with health investments for an individual’s time and money resources, but other consumption also may directly affect health. Some consumption activities, such as smoking tobacco, may provide current utility, but can be expected to increase the number of unhealthy days in later periods. Conversely, dieting or exercise may decrease the level of utility in early periods but may increase discounted lifetime utility by increasing the number of healthy days in later periods. As in the Grossman model, optimality requires that the marginal cost of the investment (forgoing the utility of consumption in an early period) must equal the present value of the marginal benefits (the added utility of consumption in later periods). Conversely, the marginal utility of
health-depleting consumption must equal the present value of the expected loss of utility in future periods.

An expanded view of health production treats net investments in health in a given period \( \Delta H_t \) as depending not only on inputs of purchased medical inputs \( M_t \) and time to medical care \( t_h \), but on choices about time spent in other consumption \( t_c \) and choices about non-medical purchased goods \( X_t \). Other household consumption activities may have either positive or negative effects on net health stocks. Similarly time spent in the labor market \( t_w \) may have either positive effects on health or negative effects due to occupational injuries.

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\Delta H_t = H(t_h, t_c, t_w, X_t, M_t, N; H_{t-1}, E)
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In addition specifying a role for an individual’s choices about allocating time and money to health promoting or health reducing activities, Eq. (1) also includes the impact on net health investments of environmental inputs \( N \) that are beyond an individual’s control. This acknowledges that air pollution or high crime levels in an individual’s environment will affect the accumulation of health capital.

In addition to education, \( E \), Eq. (1) considers that existing health stocks \( H_{t-1} \) enter into the production of additions to health capital. Thus, the marginal product of all other inputs is likely to be smaller when there are lower levels of the fixed factor, the existing stock of health.

The next section summarizes new evidence on the means by which education increases the efficiency of producing additions to the health capital stock.

### 3. New evidence on the role of education

Grossman argued that education increases efficiency in producing health and reduces the shadow price of investment at any given age. There is ample evidence of the relationship between higher levels of schooling and lower rates of mortality (Elo and Preston, 1996) and reduced prevalence of functional limitations (Freedman and Martin, 1999). Placing health in a production function context suggests that education can influence health either by increasing the returns from investment or by augmenting one’s efficiency in producing additions to health stocks.

The positive relationship between education and wage rates means that increases in future healthy days will be more valuable to persons with more schooling. Rates of return on investments in the form of purchased medical care are therefore likely to be higher for the more educated. However, higher wages would also raise the costs of time-intensive pathways to increasing health stocks, so that higher wage persons with more education may have rates of return that are no higher for these types of investments. Nonetheless, more educated people are more likely to engage in health promoting activities, including those that are time-intensive, such as exercise (Simoes et al., 1995).

More educated individuals have a comparative advantage in acquiring new information. In the past 30 years, many new health treatments have been developed and much new information has linked health habits to health. More educated people are more informed about the effects of smoking, diet and exercise on health outcomes and they have been quicker to adopt the recommended healthier lifestyles than those with less education. For example,
smoking prevalence declined for all groups following the 1964 Surgeon General’s report on smoking, but the percentage reductions in smoking were greatest for the most highly educated men and women (NCHS, 2002). Overall, those with higher levels of schooling are more likely to engage in activities that promote the development of health capital, such as exercise or healthier eating, and to avoid activities that negatively affect health capital, such as smoking and overeating (NCHS, 2002; Winkleby et al., 1992; Mokdad et al., 2003).

Since the publication of ‘The demand for health’, advances in medicine and in measurement of health inputs and intermediate outputs have allowed a test of whether more educated patients combine medical inputs more efficiently, as Grossman hypothesized in 1972. Thanks to the scientific advances and the widespread use of computers in medical billing, it is possible to test Grossman’s model of health production, using data on inputs and outputs that are measured with greater detail and accuracy and with less subjectivity than the self-reports of excellent, good, fair or poor health that were available for Grossman’s empirical analysis in 1973.

Although there is still relatively little documentation about how patients combine their own time with medical care, inferences can be made from data on the medical inputs that they use and on intermediate outputs. A recent paper by Goldman and Smith (2002) uses data on intermediate outputs in diabetes and in HIV/AIDS (sugar/mm of blood for diabetics and viral load/mm blood for persons living with HIV/AIDS) to examine the role of education in increasing the efficiency with which formal medical inputs are combined in treating these two serious diseases.

Infection with human immunodeficiency virus (HIV) provides an example where the stock of health falls precipitously rather than declining gradually as a result of aging. HIV infection progresses in a predictable manner over a relatively short period of time to deprecate the body’s ability to fight infections by destroying one kind of blood cell—CD4+ T cells (helper cells). The level of CD4+ T cells and the amount of HIV in the blood (viral load) indicate how impaired the immune system has become. Because CD4+ levels and viral loads can be readily measured, HIV allows a good test of the Grossman model.

Since 1996, highly active antiretroviral therapy (HAART) has been available to counter the effects of HIV infection. HAART, which reduces the viral load and restores the HIV-infected person’s ability to fight infections, has resulted in dramatic declines in morbidity and mortality for persons living with HIV. However, these medications require strict adherence to treatment regimens. Because HAART therapy is so tightly linked to both functional health and to mortality, HAART use and adherence present a good opportunity to test the Grossman model of the demand for health. Only 5.2% of persons living with HIV/AIDS were less than 25 years old at the time of their AIDS diagnosis (CDCP, 2003). Thus, it is likely that persons living with AIDS completed their schooling prior to their medical need for HAART therapy. Thus, we can be relatively certain in this case that the causality runs from education to health rather than the reverse.

As predicted by the Grossman model, the use of HAART by persons living with HIV is positively related to both income and education levels and negatively related to age (Andersen et al., 2000). Moreover, Goldman and Smith (2002) find that, among those on HAART therapy, more educated patients show greater compliance with the complicated HAART regimens. They also find parallel evidence of the greater efficiency in producing
health in the care of diabetes where more educated patients achieved greater control over their sugar levels.

The efficiency-enhancing effect of education may relate to the ability to follow medical regimens more reliably. A series of studies on the link between literacy and health has found that poor reading skills affect patients’ ability to read and understand labels on prescription bottles, educational materials, and informed consent forms (Wilson, 2003; Van Servellen et al., 2003). Lack of literacy has also been linked directly to poor glycemic control in diabetes (Schillinger et al., 2002) and low levels of knowledge and poor technique in using asthma inhalers (Williams et al., 1998).

The advantage that more educated persons have in obtaining health information is likely to persist due both to the continuing development of new technologies, such as genomics, and to the increasing use of the Internet as a major source for supplementing the medical advice obtained from physicians.

4. The uses of time

‘The demand for health’ argued that individuals combine inputs of time and purchased medical care to produce additions to their health stocks. The cost of a given investment can be minimized by equalizing the marginal costs of producing an increment to the health stock by additional spending on medical care and by additional time inputs. In the enhanced formulation, time in health-promoting activities includes both time spent obtaining medical care and time in other consumption that promotes health, such as exercise.

It is well known that health insurance coverage induces “moral hazard”, reducing an individual’s marginal costs of medical care inputs and leading to use of additional medical services that the patient values less than the marginal cost of producing them.

In addition, insurance reduces an individual’s cost of medical care relative to the cost of time spent in health promoting activities (Becker and Ehrlich, 1972). Health insurance biases health production decisions toward over-use of curative medical treatment at the expense of one’s own preventive efforts, as compared to the uninsured case. To the extent that many preventive efforts require a larger share of one’s own time than other types of consumption, the growth in wages over time reinforces the increasing cost of self-prevention relative to curative efforts. Within the medical care sector, as well, insurance that does not cover effective preventive treatments, such as weight loss programs also biases health care choices toward treatment rather than prevention.

Although there are theoretical reasons to believe that increases in insurance would lead individuals to substitute subsidized medical care for their own efforts in producing additions to health capital, there is as yet little empirical evidence to support this conjecture. For example, The Health Insurance Experiment, which randomly assigned levels of cost-sharing to patients, found no significant differences between participants in the free plan and the cost-sharing plans in terms of a number of health practices including, weight, level of physical activity, smoking, alcohol consumption, and seat-belt use (Newhouse et al., 1993). There are a number of possible explanations for this effect. First, any reductions in preventive behaviors among free plan participants may have been offset by their greater exposure to preventive health messages during their larger number of medical visits. It is more likely,
however, that free plan participants did not adjust their health behaviors to account for the fact that they could obtain medical care free of charge, because they knew that the consequences of bad health habits were likely to occur after the end of their three to five years enrollment in the Experiment.

One piece of evidence that is consistent with the better insured relying on medical care inputs rather than their own efforts, comes from the higher prevalence of obesity among Medicaid beneficiaries (27.4%) than among the uninsured (17.1%) (Finkelstein et al., 2003).

One must be cautious in drawing conclusions from these data, which do not control for demographic or other health factors. Nonetheless, comparing Medicaid recipients to the uninsured provides a rough control for age and poverty status.

5. Environmental factors

An expanded view of health production should include environmental as well as individual inputs to health production, as indicated in Eq. (1). Non-medical pathways that are distinct from personal health service can also create health capital (or delay the depreciation of health capital). These pathways include creating healthier living environments through pollution control, greater public safety, expanded opportunities to improve physical fitness, improved housing and education.

The personal health care sector is large in terms of personnel and expenditures compared to these environmental pathways for creating health capital. Personal health care accounted for 86.8% of the US$ 1.4 trillion U.S. health expenditures in 2001. In contrast, 3.3% was spent on Government public health activities, only a little more than half of the 6.3% share accounted for by administrative costs (NCHS, 2002). One reason for the low share of health spending devoted to population health is that population-level health investments have the characteristics of local public goods and are therefore likely to be undersupplied.

The effects of health insurance in stimulating expenditures on personal health services and the public good characteristics of population health efforts suggest that the U.S. spends too much on personal health services relative to its spending on population health initiatives. Thus, the marginal societal rate of return on personal services may be quite low relative to the rate of return on population services. The success of one population health initiative—anti-smoking campaigns and tobacco taxes—is consistent with that conjecture.

6. The initial stock of health

Grossman’s model focused on individuals’ response to the depreciation of health capital from a given initial stock. An implication of Grossman’s observation that health is endogenous is that health stocks are built up over the life course. Recent evidence documents the links between health in infancy and childhood and chronic diseases experienced in adulthood (Barker, 1997). Grossman’s basic framework can be used to provide insights to the development of human capital stock from infancy, with the amendment that investments in a child’s health depend on parental time as well as the child’s time and purchased goods that affect child health (Leibowitz, 2003). Although genetic determinants explain much of
the variation in infants’ health, parental choices are also important. For example, a pregnant woman who smokes receives immediate satisfaction from the cigarettes, but can expect to have a baby with lower birth weight. Low birth weight infants (LBW) can be characterized as having lower stocks of initial health capital than infants born at normal weight levels. The lower stock of health of LBW infants results in poorer health status throughout childhood (McGauhey et al., 1991; Currie and Hyson, 1999), consistent with the model presented in Eq. (1), where existing stocks of health are an input into producing additions to that stock.

As is the case for adult health, education enhances the productivity of health inputs. However, because the relevant education is that of the parents, it is clearer in this case that causality runs from education to health, rather than from health to education. More educated parents are more effective in compensating for the initially low levels of health capital of LBW children. LBW infants in moderate and high SES families catch up to their normal birth weight peers, whereas LBW children in high-risk social environments have increased likelihood of poor health outcomes that persists throughout childhood (McGauhey et al., 1991).

Increases in the parents’ shadow price of time will also affect the relative costs of alternative inputs to children’s health. Thus, there is concern that mothers who work outside the home may employ substitutes for their own time that are less effective in producing child health. For example, working mothers can substitute prepared foods for their own time in producing meals for their children. However, these prepared foods are often high calorie and high fat, perhaps leading to less nutritious diets for their children (Leibowitz, 2003; Anderson et al., 2003).

The health investment model places a new perspective on the observed correlation between education and health. It is not necessarily the case that health in childhood makes education more productive or that early education reduces the cost of producing additions to health capital. Rather, parents will seek to allocate their investments in children so as to equate the value at the margin of additional expenditures on health and schooling. This optimizing behavior of parents is sufficient to explain the positive correlation between the two types of human capital.

7. Directions for future research

The understanding of medical care that existed prior to the publication of ‘The demand for health’ reflected the health care challenges of the first half of the 20th century. Medicine had developed interventions that were very effective in treating acute problems, especially infections disease and accidents. Disease prevention focused on reducing health threats over which the individual had little control, such as providing safe drinking water (Breslow, 1999). Thus, models that treated health as exogenously determined could explain much of the demand for medical services. ‘The demand for health’, published shortly after the introduction of Medicare, accurately anticipated a new era for medical care, focusing on the treatment of chronic disease.

‘The demand for health’ revolutionized economists’ theorizing about health, by placing the production of health in the household production context, which emphasized the roles of both goods and time in producing health investments. Despite the great influence of
Grossman’s work on the theory of health economics, much of the empirical work on these issues in the past 30 years has focused on the demand for the goods component, while paying less attention to the time component of health production.

Researchers need to redirect their efforts from an almost exclusive analysis of the demand for medical care, and refocus attention on the production of health. There is a need for research on the underlying determinants of time uses that are destructive of health. This research might begin by increasing our understanding of why more educated people seem to be more efficient at producing health. Does their success lie in combining medical resources more effectively, as was found in the case of HIV/AIDS and diabetes? If so, can targeted education programs achieve similar effects with less educated patients? Do more educated persons make healthful choices simply because they have access to information that others lack? Or do more educated persons have lower discount rates or greater returns that make any given sacrifice of current consumption more worthwhile?

Considering health in a broader production function context casts a different light on the role of insurance. Health insurance not only lowers the cost of medical inputs and expands the use of medical care, but it also changes the ratios of marginal costs and benefits of goods and time inputs in producing health. This paper argues that this distortion of relative prices leads individuals to provide too little of their own time to promoting health. Too great a reliance on medical care for treating disease and too few investments of our own time in promoting health may be the underlying cause of the current high levels of spending on chronic diseases that are known to be caused by poor health behaviors. There is also a need for analyses of public policies designed to restore the balance in costs and benefits between subsidized medical care and other health inputs, including time and goods used in other consumption that can affect health. The tobacco tax may perhaps serve as a prototype for other health promoting public policies.

At a societal level, insurance changes the relative prices of personal and population health services. Research in health economics, like health spending, has been directed primarily to examining the determinants and outcomes of personal medical services. Research to address the cost effectiveness of community-level investments, such as improving air quality or improving neighborhood safety, will be necessary if we are to efficiently allocate public dollars between subsidies of private medical care and public efforts to promote population health.

In the years since the publication of ‘The demand for health’, knowledge about the early antecedents of adult health has grown. It is vital that we continue to explore these links and that we also improve our understanding of how children’s health capital is produced in the home. In this way we will be able to comprehend the series of investments and disinvestments, starting in infancy or even in the womb, that result in the stock of health available to an individual in old age.

References

Andersen, R., Bozette, S., Shapiro, M., St. Clair, P., Morton, S., Crystal, S., et al., 2000. Highly active antiretroviral therapy (HAART) for the HIV-positive population in the U.S.: how limited is the access of traditionally vulnerable groups? Health Services Research 35 (2), 389–416.