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The Cost-Effectiveness of Public Postsecondary Education Subsidies

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Background. **Although educational attainment is a well-recognized covariate of health status, it is rarely thought of as a tool to be used to improve health. Since fewer than 40% of U.S. citizens have a college degree, it may be possible for the government to improve the health status of the population by assuming a larger burden of the cost of postsecondary education. This paper examines the costs and health effects of a government subsidy for public postsecondary education institutions.**

Methods. **All high school graduates in 1997 were included in a decision analysis model as a hypothetical cohort. Data from the U.S. Department of Education, the World Health Organization, and the National Center for Health Statistics were used as model inputs.**

Results. **Relative to the present educational system, a federal subsidy for public and private colleges equal to the amount now paid by students for tuition and living expenses would save $6,176 and avert 0.0018 of a disability-adjusted life-year (DALY) per person annually if enrollment increased 5%. The overall savings among 1997 high school graduates would be $17.1 billion and 4,992 DALYs would be averted per year relative to the present educational system. If enrollment increased by just 3%, $3,743 would be saved and 0.0011 DALYs would be averted per person. An enrollment increase of 7% would lead to savings of $8,610 and 0.0025 DALYs would be averted per person relative to the present educational system.**

Conclusions. **If the government were to offer a full subsidy for college tuition at public universities, both lives and money would be saved, so long as enrollment levels increased. Providing a free postsecondary education for students attending public schools may be more cost-effective than most health investments.**

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Key Words: **cost–benefit analysis; cost savings; socioeconomic factors.**

INTRODUCTION

Federal, state, and local governments in the United States spent approximately $560 billion on education and just under $500 billion on health care in 1997 [*1,2*]. While most economic analyses of medical interventions utilize cost–effectiveness methodology, nonmedical interventions typically use cost-benefit methodology. Because these methods are not comparable, policy makers do not have adequate information on the proper allocation of resources between medical and nonmedical social investments.

Medical researchers have long recognized the positive impact of education on an individual's health outcomes [*3–7*]. Education is strongly correlated with the relative risk of almost all causes of mortality; those who have completed 1 year of primary school education may be at 2–4 times greater risk of premature death than doctoral-level graduates in the United States after controlling for race, marital status, income, and risky health behaviors [*8–10*].

Socioeconomic status has been shown to predict future health outcomes among healthy persons, there is consistency between studies that examine the impact of SES on health outcomes, there is a linear dose–response relationship between the relative socioeconomic position of persons and health outcomes, and the association between low SES and poor health outcomes is strong [*8–11*].

After controlling for income, the dose–response relationship between educational attainment and all-cause mortality is similar between grades 1 through 12 (when the vast majority of the population is enrolled in school) and college through advanced degrees (when relatively few persons are enrolled) [*9,11*]. This suggests that increasing educational attainment above grade 12 would produce improvements in health status regardless of

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enrollment levels. Nonetheless, there is some doubt as to whether improving the overall level of education in a population will lower the overall incidence of disease and death. In this analysis, we examine returns on educational subsidies for postsecondary education and explore the potential reduction in morbidity and mortality rates resulting from increased enrollment.

It is generally agreed that investments in education produce long-term financial returns for both individuals and governments [*12–15*]. Still, only approximately 30% of all males and 40% of all females complete college, in part because costs are perceived to be prohibitive for some persons [*1,16*]. In the United States, postsecondary education is subsidized at the federal, state, and local level, but the student typically pays an average of $7,600 dollars at public schools and $13,300 dollars at private schools in annual tuition alone [*1*].

Enrollment levels appear to be price sensitive. The Servicemen's Readjustment Act of 1944, which paid tuition fees for American soldiers returning from the second world war, appears to have been responsible for the 100% increase in college enrollment levels by 1947 [*17,18*]. Recently, increases in tuition in the United States appear to have resulted in declining enrollment in private institutions and dramatic increases in enrollment at less expensive public institutions [*16*]. In England, post-secondary enrollment rates were increasing until the government announced its plan of instituting nominal means tested tuition fees [*19*]. After announcing the plan, enrollment rates dropped 2.4% for some groups of students. Elementary schools under the "I Have a Dream Foundation" umbrella, which finances college education for underprivileged children, have dramatically improved retention rates (presumably because students or their parents see college attendance as a possibility) [*20*]. The rate of college enrollment for these students has increased up to 300% relative to ecological control sites.

We examine health outcomes using the disability-adjusted life-year (DALY). A DALY represents 1 year of healthy life lost due to disease.

METHODS

The graduating high school class of 1996–1997 was used as a hypothetical cohort. We generally adhered to the recommendations of the Panel on Cost-Effectiveness and Medicine's "reference case" guidelines, however, we did not include all cost savings from postsecondary education as is recommended and used the disability-adjusted life year rather than the quality-adjusted life-year [*21*]. We failed to include all costs because educational subsidies were found to be cost saving in our initial analysis and we used the DALY because data specific to this measure were readily available. All future costs and health outcomes were discounted at a rate of 3% and all costs were adjusted to 1997 dollars.

Decision Analysis Model

A decision tree was constructed on DATA 3.0 for the Macintosh (TreeAge Software Inc., Williamstown, MA). In this model, three possible outcomes are evaluated: (1) the U.S. government provides a full subsidy for tuition and living expenses for students enrolled in public institutions, (2) students who were otherwise willing to pay for their education are subsidized but enrollment levels remain constant, and (3) the present rate of subsidization is maintained. In the first scenario, all newly entering students receive a subsidy, but only those students who attend school realize health and economic gains. In the second scenario, all students receive subsidies, but no additional health or economic gains are realized because enrollment levels do not increase. In the final scenario, no additional subsidy is provided and no additional students attend.

Since the model could not account for varying market conditions as enrollment levels increase [*22,23*], we examined the effects of small increases, using the most conservative estimates of demand for free education [*20*]. The parameters we used as model inputs are listed in Table 1.

Cost of Education

All costs associated with education were obtained from the National Center for Education Statistics [*1,24*]. Income differentials by level of education were obtained from the Bureau of the Census [*25,26*]. We also included the cost of the federal loan program administration and loan default payments [*27*] and the

TABLE 1

Parameters Used in Decision Analysis Model at a discount Rate of 3 and 0%

	3%	0%
Costs		
Tuition and living expenses	$27,110	$30,512
Pell grant administration	$94	$106
Medical care		
High school graduates	$86,891	$183,454
College graduates	$32,531	$71,118
Income		
High school graduates	$336,055	$1,348,219
College graduates	$487,661	$1,738,275
DALYs[a]		
High school graduates	21,938,533	29,483,554
College graduates	12,167,954	16,352,712

Note. All numbers reflect lifetime totals.
[a] Disability-adjusted life-years.

cost of future health care averted in persons of higher educational attainment [*28–30*].

Four assumptions were made regarding costs: (1) all persons would retire at age 65, (2) bachelor's-level graduates who attend college because education is free would not go on to higher degrees (and thus higher earnings), (3) students would not work while in college (and would thus forgo income), and (4) no increase in real wages would occur over the 43 years graduates spend in the workforce. Each of these assumptions favors the hypothesis that education is not a cost-effective way to improve a population's health status and likely produced an underestimate of the cost-effectiveness of educational subsidies. Moreover, future earnings from investments, such as individual retirement accounts, and costs associated with federal programs (i.e. welfare, daycare, and foster care) that may be more frequently utilized by groups of low educational attainment were excluded from the analysis.

Higher education in the United States is partially subsidized by local and state governments, charitable contributions, sales, and investment interest [*1*]. We assumed that local political realities would likely prohibit increased payments for additional students and that charitable institutions would become disinterested in assisting students when the burden of payment is shifted toward the federal government.

Medical Costs and Health Effects

Data from the National Center for Health Statistics [*29,30*] were used to apportion costs and disability-adjusted life-years by educational attainment. To calculate deaths averted and DALYs averted by educational attainment, total deaths and DALYs were obtained from the Global Burden of Disease [*32*] for three age groups, 15 to 44, 45 to 60, and 60 and over. We then computed the total burden of disease for persons 18 and over by educational attainment using a linear regression model, entering age as an independent variable and the mortality ratio as a dependent variable ($R^2 = 0.996$; $\beta = 0.026$). Because the Global Burden of Disease contains burden of disease estimates by region rather than country, it was necessary to derive the proportionate burden of disease in the United States using population data and burden of disease estimates for industrialized nations [*33*]. Disability-adjusted life-years are typically age-weighted so that a year of life lived by a young adult year is assigned a higher value than a year of life lived by an elderly person or a child. We did not include these age-weighted parameters in our analysis.

The per capita medical cost for Medicare, Medicaid, and private insurance plan enrollees was obtained from the Health Care Financing Administration [*28*]. These costs were then apportioned by educational attainment using data from the National Health Interview Survey [*29,30*]. Differentials in medical utilization (physician contacts per person) and disease prevalence ratios were not available by educational attainment but were available by income [*28*]. We adjusted these data by corresponding the mean income of high school graduates and college graduates to income specific data reported on the National Health Interview Survey [*28*].

Sensitivity Analysis

We conducted a multivariate sensitivity analysis to determine which variables exerted the most influence on model outcomes. We then conducted one-way sensitivity analyses on all variables demonstrating a significant influence on the decision model. We included three conservative scenarios in our model. In the first, a full government subsidy for education and living expenses increases enrollment by 3%, the smallest effect seen among impoverished persons in ecologically controlled studies of subsidies for postsecondary education [*20*]. In the second and third scenarios, we examined the effect of enrollment increases of 5 and 7%, respectively. We also examined the effect of removing discounting from all future costs and health outcomes. Finally, we conducted a threshold analysis to illustrate the relationship between increases in enrollment levels and the number of DALYs averted in the U.S. population.

RESULTS

If education in public universities were fully subsidized by the federal government and enrollment increased by just 3%, the savings associated with future improvements in income and reduced health expenditures would have been approximately $3,743 per 1997 high school graduate (10.3 billion dollars overall) relative to the present system. Approximately 0.0011 disability-adjusted life-years per graduate would also have been averted (2,995 overall [see Table 2]). If enrollment had increased to 5%, $6,176 would have been saved and 0.0018 DALYs would have been averted for each graduate relative to the present system. If enrollment had increased to 7%, monetary savings would have been $8,610 and 0.0025 DALYs would have been averted relative to the present system. If enrollment had increased by 7%, 1997 high school graduates would have saved a total of $23,841,090,000 and averted a total of 6,988 DALYs relative to the present system in which the student is expected to pay tuition and living expenses.

It is conceivable that older students would be more likely to enroll in college as well. To examine the impact of increasing the overall number of college graduates in the United States, we examined the relationship between improvements in healthy life in the United States and increases in the total number of college graduates at a 3% discount rate (see Fig. 1). With a 10%

TABLE 2

Cost Savings and Disability Life-Years Averted at Enrollment Rate Increases of 3, 5, and 7% and Discount Rates of 3 and 0% under a Free Postsecondary Education System

	Cost savings		DALYs[a] Averted	
	3%	0%	3%	0%
3% Increase				
Per student	$3,743	$9,370	0.0011	0.0015
Total[b]	$10,364,367,000	$25,945,530,000	2,995	4,025
5% Increase				
Per student	$6,176	$15,542	0.0018	0.0024
Total[b]	$17,101,344,000	$43,035,798,000	4,992	6,708
7% Increase				
Per student	$8,610	$21,715	0.0025	0.0034
Total[b]	$23,841,090,000	$60,128,835,000	6,988	9,392

[a] Disability-adjusted life years.
[b] For 1997 high school graduates in the United States.

overall increase in college graduates in the U.S. population, the total number of DALYs would be reduced from approximately 34 million to fewer than 33 million. With a 20% increase in enrollment, the total number of years of healthy life lost to disease would be reduced to approximately 31 million.

The rate of discount used exerted a large effect on the overall savings in healthy life-years and money, but had little effect on the dominance of full tuition and living expense subsidies over the present system. Likewise, error in parameter estimates for costs saved and DALYs averted had little effect on the overall model.

DISCUSSION

We found that a full government subsidy for tuition and living expenses for undergraduate postsecondary education in public institutions would be cost saving and life saving relative to the present system, so long as this policy led to an increase in enrollment. Among the 1997 high school graduates, a 5% increase in enrollment would have led to savings of $17 billion and almost 5,000 years of healthy life would have been gained. If enrollment in the United States were to increase by 5% overall, almost a half million years of healthy life would be gained.

The finding that educational investment is cost saving is not new. Cost–benefit analyses, which include a monetary valuation of human life, have found that education produces fiscal returns for both individuals and governments [*12–15*]. However, to our knowledge, this is the first cost-effectiveness analysis examining educational investments. Cost-effectiveness analyses are typically applied to health care interventions and present the incremental cost associated with a gain in

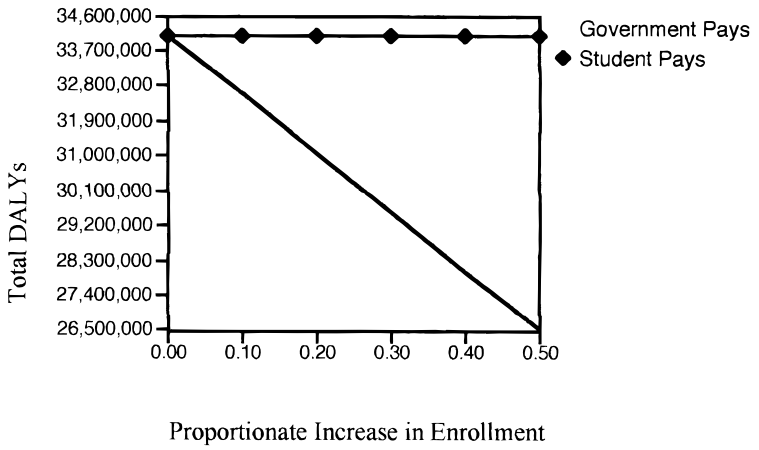

FIG. 1. Relationship between the proportionate increase in enrollment under a free postsecondary education system and the total number of DALYs in the United States at a 3% discount rate.

healthy life [*21*]. Few health interventions have been found to be cost saving and life saving [*34*]. Those that are typically performed involve preventive strategies targeted to high-risk populations, such as pneumococcal vaccination in the elderly and presumptive antiparasitic therapy in immigrant populations [*35,36*]. We demonstrate that, when policy makers wish to invest in health, investments in postsecondary education may be a better buy than most investments in medical interventions.

The analysis may overestimate the costs associated with a governmental subsidy for education and underestimates returns. Most savings associated with social investments for citizens of low socioeconomic status, which span the spectrum of social welfare investments from increased foster care needs to reduced imprisonment, were not included. If we had included the savings associated with reduced utilization of these social services, the projected savings would likely be higher. Moreover, the three scenarios we present in this study represent conservative estimates of increases in enrollment levels. When offered a free college education, underprivileged children may be three times as likely to attend college and may be less likely to drop out of secondary school [*20*]. If college enrollment levels among this group of adolescents increased by just 11%, overall college enrollment rates would jump by almost 3%.

The primary limitation of the study is the assumption that increasing educational attainment would improve the nation's health status. Causality has not been firmly established in links between education and all-cause mortality rates or morbidity rates. Whether or not the relationship is causal, domestic studies and international comparisons strongly support the hypothesis that improving educational attainment will improve healthy life expectancy [*3–11*]. If this is not the case, educational investments would only be viewed as a cost-beneficial rather than a cost-effective strategy.

A second limitation is that the model fails to consider the overall macroeconomic effects of saturating the job market with highly educated individuals. Our model will likely predict improvements in earnings for college-educated persons accurately, so long as enrollment increases by less than 10 to 20%. For this reason, we used only the most conservative estimates of demand for education under a free system [*20*]. International data suggest that countries with large numbers of college-educated persons, but few jobs, still realize an economic benefit from large investments in postsecondary education programs, albeit greatly diminished relative to countries with undersaturated markets [*22–23*]. There is also evidence that education remains a strong predictor of health status after controlling for income [*8,9*]. Moreover, relative to the estimate of returns for college education predicted by the U.S. government, our estimates are conservative. We estimate that undiscounted returns on educational investments would amount to approximately $390,000 over a lifetime while the Bureau of Commerce estimates that returns would be approximately $600,000 [*37*]. These researchers estimate that earnings differentials will increase, even as college enrollment levels steadily increase.

Another limitation of the study is that we used the disability-adjusted life-year rather than the quality-adjusted life-year to determine gains in healthy life expectancy. The DALY measures quality of life lived with disease using the controversial physician trade-off method rather than more accepted methods such as the time trade off or standard gamble [*32*]. The DALY may produce burden of disease estimates that differ from other quality-adjusted measures (Gold and Muennig, unpublished data).

Finally, this study was limited by our use of risk ratios for all-cause mortality rates by educational attainment to adjust the parameters used in this analysis. In doing so, it was necessary to assume that disease prevalence rates, mortality rates, and costs would vary in equal proportions by educational attainment. Using income as a surrogate measure, we found that, in aggregate, this assumption roughly holds for prevalent conditions measured by the National Health Interview Survey [*29,30*]. Moreover, our sensitivity analyses revealed that this assumption would have no effect on the dominance of full federal educational subsidies over the present educational system.

There are currently a number of federal initiatives aimed at increasing college enrollment. These include federal grant programs, public–private partnerships, and nonprofit programs, among others [*38,39*]. If the federal government were to assume the responsibility of subsidizing public institutions, these organizations would be free to invest elsewhere. However the opportunity cost of such investments is difficult to measure.

We only included the costs associated with administering the Pell grant program, the nation's largest educational grant program, in our analysis, since data for other program initiatives were too complex to analyze. The overall cost of a full governmental subsidy for tuition and living expenses in public institutions—appoximately $55 billion in 1997—would likely be offset by reducing the total number of government programs needed. The scenario we present—a full subsidy for tuition and living expenses at public institutions—may be perceived as too costly by legislators over the short term, since most benefits would be realized in the future. However, it is likely that similar benefits could be realized with means tested subsidies at a lower initial cost. A means tested strategy, though, would not

eliminate overhead costs associated with the many governmental and institutional bureaucracies that currently assist students in obtaining financial aid and would likely produce lower overall returns.

While low-cost public universities are bursting at the seams with new applicants, many private universities are left scrambling to court competitive applicants [*16*]. Given that educational investments produce returns for society as a whole and the cost of higher education may be prohibitive for some families, politicians may find that offering free college tuition would be a more attractive to voters than tax cuts during election years.

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