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Cumulative Advantage, Educational Attainment, and Late Life Health Status

Michele J. Siegel*, Ayse Akincigil**, Shahla Amin* and Stephen Crystal**

1 Introduction

There is clearly a strong association between economic advantage and health status in late life, but much remains to be understood about the nature of this relationship. Few studies have examined the distinct relationship between various aspects of socioeconomic status (SES), such as income and educational attainment, and late life health status. Similarly, few studies have examined the differential extent to which various aspects of late life health status – such as prevalence of specific chronic conditions, functional impairment, and self-rated health – are related to SES. As well, few studies have examined the pathways through which various components of late life health status are related to SES. Yet the estimated effect of SES on late life health is likely to depend on the aspect of SES and health status examined.

The relationship between SES and health begins in childhood. Life course models focus on the extent to which illness in childhood has lasting effects on health in adulthood, directly through the illness itself and indirectly by restricting educational attainment, which results in poorer labor market skills and lower earnings (Case, Fertig, and Paxson, 2005; Kuh and Wadsworth, 1993). Prenatal and childhood health appear to have a direct effect on health and economic status in middle age (Case, Fertig, and Paxson, 2005). Children born to poorer parents may be more likely to have a poorer fetal environment, and nutrition in utero can affect coronary heart disease and diabetes in middle age (Barker, 1995). Mothers' education predicts self-rated health at age 42, and children from higher income families have higher educational attainment, even controlling for parental schooling (Case, Fertig, and Paxson, 2005). Family background, particularly family income, is associated with both access to higher education and labor market attachment (Blanden, Gregg,

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and Macmillan, 2006). Nonetheless, intergenerational income mobility depends somewhat on public policies, such as the progressivity of government investments in children's human capital; the United States and United Kingdom appear to be less mobile societies than are Canada, Finland and Sweden (Solon, 2002).

The relationship between schooling and late life outcomes is of particular interest because educational attainment remains largely fixed after the third decade of life, and is not affected by midlife and late life health change (Ross and Wu, 1996). Thus, it can be considered in some sense as causally prior to income in late life. The impact of educational attainment in the early part of the life course on subsequent economic outcomes does not appear to diminish many decades later as cohorts reach retirement age, despite the many vicissitudes of life in the intervening years. Crystal, Shea and Krishnaswami found that years of schooling were more predictive of income after age 65 than at earlier ages (Crystal, Shea, and Krishnaswami, 1992). The cumulative advantage model postulates that the effects of early advantages and disadvantages cumulate over the life course. While some argue that health inequalities decrease over the later life course (Beckett, 2000; House, Kessler, and Herzog, 1990), others have found that educational disparities in health increase with age (Crystal and Shea, 1990; Crystal and Waehrer, 1996; Goldman and Lakdawalla, 2001; Ross and Wu, 1996). If not offset by protective social welfare policies, this is likely to lead to greater inequality in later life than during the working years (Crystal and Shea, 1990; Crystal and Waehrer, 1996).

The pathways through which schooling and subsequent economic outcomes influence late life health, in ways that may cumulate over the life course, are complex and the subject of considerable debate. The obvious economic explanation for the pathway through which education affects late life health is through the effect of education on lifetime income. Education may give an individual "a wide range of serviceable resources, including money, knowledge, prestige, power, and beneficial social conditions that can be used to one's health advantage" (Cutler and Lleras-Muney, 2006; Link and Phelan, 1995). Income may be important because of its link with social position and with opportunities to exercise control over one's life (Marmot, 2002). However, income explains only about a third of education's effect on health (Cutler and Lleras-Muney, 2006).

Schooling also affects late life health through its effect on occupation, since occupation potentially affects many of the mid and late life outcomes including health insurance coverage. In the U.S., the more educated are more likely to enter occupations with benefits such as health insurance (Crystal and Waehrer, 1996) and thus have better access to care (Andrulis, 1998). Yet, the British Whitehall study, in a country with universal health insurance, suggests other pathways through which education affects late life health. A twenty-five year follow-up of the first Whitehall study found that the higher the position on the occupational hierarchy, the lower the mortality rate from all causes, particularly coronary heart disease (Marmot, 2002).

Position in the occupational hierarchy, that is employment grade, was more predictive of self-rated health than income (Marmot, 2002). Social position, measured by income or occupation, may affect health through its influence on psychosocial stressors that affect the neuroendocrine system, i.e., "allostatic load", and the risk of cardiac disease (Marmot, 2003b).

The link between education and late life health through the impact of education on access to health insurance is a particularly salient issue in the U.S., where in contrast to virtually all other developed countries, universal access to health coverage depends on age. In the U.S., a significant minority of individuals under age 65, particularly the economically disadvantaged, lack health insurance coverage (DeNavas-Walt, Proctor, and Smith, 2007). After age 65 nearly all are eligible for basic coverage under Medicare, which is received by 97%-98% of the U.S. elderly (Davis and Burner, 1995; Moon, 2006). Thus, in the U.S., some suggest that Medicare reduces health disparities in late life and that the greatest health disparities exist in middle adulthood at ages 45–64 (Adler and Newman, 2002). However, studies of newly eligible Medicare beneficiaries do not show a marked decrease in disparities due to comparable coverage. Educational disparities in physical functioning and self-rated health have been shown to increase with age (Mirowsky and Ross, 2008; Ross and Wu, 1996).

One possible explanation is that the availability of universal coverage at age 65 through Medicare is too late if disparities in healthcare access at midlife set the stage for late life disparities. Poor health among the less educated in midlife may set the stage for health disparities in late life, suggesting that improved healthcare coverage in midlife when chronic conditions first develop could buffer late life educational disparities in health. A second possible explanation is that having Medicare alone does not lead to comparable coverage across income groups. Although governmentally-provided health coverage in the U.S. is age-tested in ways that are not typical of most other developed countries, coverage for the U.S. elderly is actually an example of a hybrid public-private system rather than a pure social-insurance one, since Medicare pays for only about 60% of the elderly's healthcare costs. There are substantial gaps in the scope of Medicare's coverage, and significant deductibles and copayments are faced by those with the traditional Medicare program alone. Without supplemental insurance, enrollees' share of healthcare costs is still quite high (Davis and Burner, 1995; Khandker and McCormack, 1999; Pourat, Rice, Kominski and Snyder, 2000; Rowland and Lyons, 1996). To obtain assistance with these out-of-pocket costs, those who can afford it tend to buy supplemental insurance (often called Medigap policies) (Pourat, Rice, Kominski and Snyder, 2000; Rowland and Lyons, 1996). Some obtain this supplemental coverage from their prior employer, a type of access that would in turn be correlated with their occupation and thus education level. Those with sufficiently low income qualify for Medicaid, a government insurance program serving the poor (Pourat, Rice, Kominski and Snyder, 2000; Rowland and

Lyons, 1996). Thus, while Medicare does provide a basic level of coverage for all elderly, coverage disparities remain.

Education is also likely to affect late life health status through its influence on healthcare use and access. Lower socioeconomic position is associated with less healthcare access and lower overall healthcare use, even among those with health insurance. Fiscella, Franks, Gold and Clancy, suggest that the pathways through which socioeconomic position affect healthcare use likely include healthcare affordability and geographic access, patient attitudes, preferences, health beliefs, literacy, knowledge, education, transportation and competing demands and provider bias (Fiscella, Franks, Gold and Clancy, 2000). Healthcare access can influence recognition and diagnosis of treatable health conditions such as depression (Crystal, Sambamoorthi, Walkup and Akincigil, 2003). Among those with access, socioeconomic position, as measured by education or income, is related to standard measures of healthcare quality (Fiscella and Franks, 2000; Fiscella, Franks, Gold and Clancy, 2000). These disparities in healthcare quality are likely to differentially affect the various dimensions of health.

The relative strength of the association between education and the various health outcomes is not well understood, and the precise relationship between education and health in late life is likely to vary with the aspect of health examined. Some argue that there is a convergence in health differentials in late life due to selective survivorship, a hypothesis initially proposed to explain the "racial mortality crossover" under which the survival advantage of whites became a mortality disadvantage at the oldest ages. This hypothesis was subsequently advanced to explain narrowing health and mortality differentials by SES (Beckett, 2000; Robert and House, 1994). Nonetheless, differences in mortality rates by education level have been found to increase with age (Lauderdale, 2001; Preston and Elo, 1995), due to a wide range of factors (Lantz et al., 1998). The relationship between SES and mortality is stronger for highly preventable causes of disease (e.g., chronic obstructive pulmonary disease, diabetes, heart disease), than for less preventable causes of death (e.g., brain cancer) (Phelan and Link, 2005). Ischemic heart disease, lung cancer, stroke, pneumonia, congestive heart failure and lung disease, account for 40% of the disparities by education level in years of life lost (Wong et al., 2002).

Education is associated with the incidence and prevalence of several chronic health conditions (Cutler and Lleras-Muney, 2006; Hayward et al., 2000). The prevalence of diabetes has increased in recent decades, and it has increased the most among those without a high school degree (Kanjilal et al., 2006). The less educated have higher morbidity from most common acute and chronic conditions: heart conditions, stroke, hypertension, emphysema, diabetes, asthma, and ulcers (Cutler and Lleras-Muney, 2006), due to an array of factors. Education may be associated with unhealthy living and working conditions, through its effect on occupation (Lynch, 2003); yet occupational exposure aside, the impact of SES (particularly education)

on chronic obstructive pulmonary disease (COPD) is second only to that of smoking (Prescott and Vestbo, 1999). Those with less education are more likely to smoke, drink a lot, or be overweight, and education directly affects health behaviors and use of secondary prevention for chronic health conditions and other medical risk factors (Cutler and Lleras-Muney, 2006). Disabling diseases such as arthritis, back pain, asthma and COPD contribute to educational disparities in disability-free life expectancy (Nusselder et al., 2005). Better adherence and self-management of chronic conditions among the more educated is associated with better self-rated health (Goldman and Smith, 2002). Education is strongly associated with late-life physical function and self-rated health (Ross and Wu, 1996).

There is also a pronounced income gradient in self-reported chronic conditions, including diabetes, hypertension, heart disease, myocardial infarction, stroke, and lung disease (Banks et al., 2006). Respondents with higher incomes had lower levels of functional limitation (Minkler, Fuller-Thomson, and Guralnik, 2006). It appears that education plays a greater role relative to income in the onset of functional limitations, while income has a greater effect on their progression or course (House, Lantz, and Herd, 2005). While education improves self-rated health, its effects are larger at lower levels of income. Conversely, the strength of the positive relationship between income and self-rated health varies with the level of education. Thus, the better educated have better self-rated health at all income levels, and there are fewer income-based health disparities among the well-educated (Schnittker, 2004).

Yet, despite an extensive literature, the pathways through which SES influences various aspects of late life health, including the prevalence of specific chronic conditions, functional impairment and self-rated health, remain somewhat unclear. In this study, we examine the relationships among educational attainment, income, insurance and access to healthcare, and various facets of late life health status, among Medicare enrollees age 65 or above. We use a large database representative of the non-institutionalized elderly in the U.S. to examine whether the relationship between education and health status in late life remains across multiple domains of health, after controlling for income, supplemental insurance status, and access to care.

2 Conceptual framework

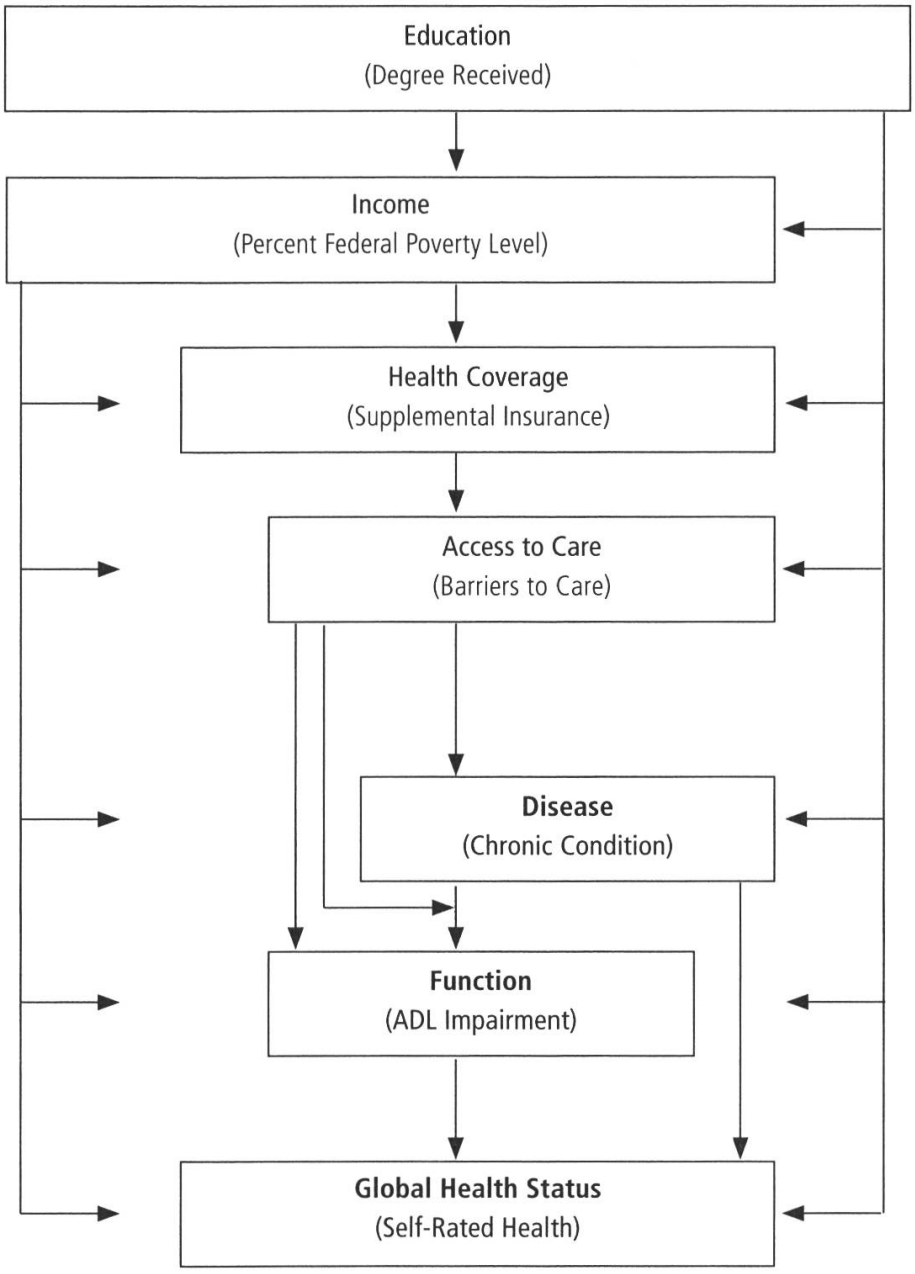
As the above discussion suggests, the direct and indirect effect of education on the various domains of late life health varies with the aspect of health examined. The factors mediating the relationship between education and late life health can be illustrated by the conceptual model outlined in Figure 1 below, adopted from a larger framework developed by Crystal and Shea (Crystal and Shea, 2003). This cumulative advantage model of disease, impairment and disability over the life course combines our earlier-articulated cumulative advantage/cumulative disadvantage perspective

(Crystal and Shea, 1990) with perspectives from disablement theory (World Health Organization, 1980) that characterize the process by which biological changes in individuals, such as particular chronic diseases, ultimately lead (or do not lead) to functional differences and other health-related outcomes (Johnson and Wolinsky, 1993; Verbrugge and Jette, 1994). A common feature of both perspectives is that while both examine sequences of individual-level events over the life course, both go beyond the individual level to view these sequences as shaped by socioeconomic settings, constraints and institutions (Crystal and Waehrer, 1996; O'Rand, 1996, 1996; Verbrugge and Jette, 1994). For example, work in the cumulative advantage tradition has examined the influence of early educational advantages on late life income, while noting that this relationship is mediated by policies and institutions such as the structure of retirement income systems. Disablement theorists would note that disease may or may not lead to impairment and disability; the relationship is mediated by factors such as occupation during the working career and availability of rehabilitative services, treatments to manage the impact of chronic illnesses, and access to assistive devices. Thus, the impact of individual-level life-course events on more distal outcomes is seen as being moderated by resources and demands of the social and institutional environment (Crystal and Shea, 2003).

We focus on three domains of health: chronic disease conditions; functional impairment in activities of daily living (ADLs); and self-rated health. Although each of these may affect the others, we postulate consistent with the disablement perspective that the principal pathways proceed from physiological dysfunction (medical conditions) to performance limitation (functional status) to global perceived health status (self-rated health). This conceptualization provides a framework for examining the association between educational attainment and later health outcomes. For example, those with less formal education are at higher risk of specific conditions such as diabetes, hypertension, obstructive pulmonary disease, or cardiac disease. These conditions affect functional outcomes, but those with educational advantages may also be better able to reduce the impact of these conditions or slow their progression by seeking out and accessing appropriate healthcare, or by self-care/behavioral change strategies, decreasing the impact of their conditions on functional impairment (e.g., the ability to perform specific tasks such as lifting, climbing stairs, or walking specified distances). These impairments in their turn increase the risk of worse self-perceived health, which has been shown to be among the best global measures of general health status (Idler and Benyamini, 1997). Figure 1 illustrates the predominant pathways postulated to shape these relationships.

As shown in the Figure, education is postulated to affect the three domains of health both directly and through its effect on income, supplemental insurance and access to care. Since educational attainment remains largely fixed after the third decade of life, it can be thought of as causally prior to late life financial health. Income, supplemental insurance and access to care all mediate the effect of education

Figure 1: Conceptual model



on late life health. Income is in the causal pathway between education and late life health, and affects the three aspects of health both directly and through its effect on supplemental insurance and access to care.

As the prior literature suggests, the three health outcomes are not independent of one another. The prevalence, severity and management of chronic conditions affect the development and management of functional limitations. The relationship between chronic conditions and functional impairment is moderated by access to care (Crystal and Shea, 2003). Self-rated health is influenced by the prevalence and

severity of chronic conditions and functional limitations. Modeling the relationship among these three dimensions of health in this way is somewhat of a simplification, but it accords with how the constructs of disease, functional impairment, and self-rated health are likely to interrelate, and how their interrelationship has been conceptualized in the literature (Hoeymans et al., 1997; Johnson and Wolinsky, 1993; Verbrugge and Jette, 1994). Johnson and Wolinsky (1993) used structural equation modeling to confirm this comprehensive model of the structure of health status.

Thus, as the conceptual model suggests: (1) enrollee chronic conditions reflect education, income, supplemental insurance and access to care; (2) functional limitations reflect the same SES related factors and chronic conditions; and (3) self-rated health is influenced by these SES factors and chronic conditions and functional limitations. As with any conceptual framework, this model is an intentionally abstracted version of complex interrelationships, and entails trade-offs among clarity, utility and completeness. While other pathways between constructs could certainly be justified, the current model serves a heuristic purpose in guiding an exploration of the most important postulated directions of influence.

3 Methods

3.1 Data

The Medicare Current Beneficiary Survey (MCBS) provides health status and utilization information on a large, nationally representative sample of the Medicare population. MCBS is a longitudinal dataset, employing a four-year rotating panel design. We used data from 1992 to 2005. MCBS combines survey and administrative data, with participants chosen through a multistage probability sampling of the Medicare population (aged, disabled and institutionalized). Survey data include information on beneficiary healthcare use and costs, health status, health insurance coverage, access to care and use of services. Survey data are matched with paid claims filed by healthcare providers for the services paid by Medicare.

3.2 Participants

Our study population consisted of elderly Medicare beneficiaries age 65 or above. The first year of interview data were used for each respondent. We excluded individuals who died, became eligible for Medicare partway during the year, or did not have full year Medicare enrollment. The sample was further restricted to respondents living in the community for the entire year, since healthcare use and financing among institutionalized populations is not comparable to that for community dwelling elderly. Since one of our included chronic conditions, a depression diagnosis, was based on Medicare claims as described below, the final sample was restricted to the population in traditional indemnity plans because the requisite claims data were

not available for services financed by Medicare managed care plans. This resulted in a sample of 39,268 beneficiaries. Since traditional indemnity plans continue to be the dominant payment system within Medicare, including approximately 87% of beneficiaries (Biles et al., 2006), this population is largely representative of the elderly population overall.

3.3 Measures

3.3.1 Outcome measures

Consistent with the conceptual framework above, we focused on three domains of health: disease, function, and global health status. The disease construct was operationalized by the presence of major chronic health conditions; function was operationalized with a measure of impairment in activities of daily living (ADLs); and global health status was operationalized by self-reported overall health status.

These three outcome measures were treated as ordinal variables, since it cannot be assumed that the effect of having one additional condition or limitation, or a better health rating, is always the same, regardless of the baseline value or conditions or limitations included. Thus, we estimated a proportional odds model for each of the outcome measures, with a cumulative logit link for ordinal responses (McCullagh, 1980). This model assumes that, although the constants are estimated separately for each response value, the effect of the independent variables is proportional. Thus, the odds ratio for each predictor is constant across all possible collapsings of the response variable, and odds ratios indicate the odds of being "lower" or "higher" on the outcome variable across the entire range of the outcome (Gameroff, 2005).

Chronic medical conditions: Conditions included were arthritis, cancer, diabetes, heart disease, hypertension, lung disease, stroke and depression. These diseases were selected because of their high prevalence and impact among middle aged and elderly persons (Wallace and Herzog, 1995). All conditions except depression were self-reported, with the question worded as "has a doctor ever told you that you have [condition]". Depression was based on whether a medical care provider recorded depression as the primary or secondary diagnosis on an insurance claim form during the observation year. We aggregated these eight chronic conditions into an index ranging from 0 to 8. While we counted the number of conditions without taking their severity into account, these conditions are not likely to be independent and thus people with more severe symptoms are likely to score higher (Dwyer and Mitchell, 1999).

Functional impairment: This was measured by limitations in activities of daily living (ADLs). The ADL scale, ranging from 0 to 6, included difficulty in bathing/showering, dressing, eating, getting in/out of bed/chair, walking, and using the toilet. Additional restrictions on functioning were reflected in higher index values. ADL limitation has a pervasive effect on ability to function in a wide variety of

activities, and similar indices are widely used in aging research as overall measures of functional limitation (Guralnik and Ferrucci, 2003; Katz et al., 1970; Miller et al., 2006; Nagi, 1976; Wiener et al., 1990).

Self-rated health status: Respondents were asked to rate their health as excellent, very good, good, fair, or poor. The resulting measure, self-rated health, has been shown, in a substantial research literature, to be a valid, reliable measure of overall health, combining the different components of how people perceive their overall health, and highly predictive of outcomes such as morbidity and mortality (Idler and Benyamini, 1997).

3.3.2 Explanatory variables

These included educational attainment, income, supplemental insurance coverage and access to care. They were analyzed in nested models, consistent with the conceptual framework.

Educational attainment: Education was measured by three indicator variables, one for respondents who did not graduate high school, the second for respondents with a high school diploma as their terminal degree, and the third for respondents who attended some college or received an associate degree; the reference group was respondents with at least a college degree.

Income: Income was measured as a percent of the federal poverty level (FPL), using three indicator variables, one for respondents with income below 100% of the FPL, the second for respondents with income between 100% and 200% of the FPL, and the third for respondents with income between 200% and 400% of the FPL; income above 400% of the FPL was the reference group[1]. While we measured income in late life rather than earlier in the life course (for example, during the critical pre-retirement years), a number of studies have shown that post-retirement income is strongly predicted by pre-retirement income (Crystal, Shea, and Krishnaswami, 1992).

Supplemental insurance coverage: While our sample is composed of Medicare enrollees, Medicare by itself leaves significant gaps in coverage and, without supplemental coverage, exposes beneficiaries to significant out of pocket cost burdens that can hinder appropriate use of services (Davis, Moon, Cooper and Schoen, 2005; Khandker and McCormack, 1999; Pourat, Rice, Kominski and Snyder, 2000; Rowland and Lyons, 1996). Thus, we used two binary indicators of whether the respondent had supplemental medical insurance in addition to Medicare, one for coverage through Medicaid and a second for supplemental employer-sponsored or self-purchased private medical insurance. The reference group consisted of enrollees

1 The MCBS reported the combined income of the respondent and spouse if the respondent was married; it reported the personal income of only the respondent if divorced, widowed, or never married. For single respondents, the FPL for a one person family was used for the denominator; for married respondents, the FPL for a two person family was used, applying U.S. government poverty thresholds (http: //aspe.hhs.gov/poverty/figures-fed-reg.shtml).

with no medical insurance other than Medicare. Medicaid, a means-tested benefit, is received by Medicare beneficiaries with low income and assets; it tends to be received by a low-income population with more medical care needs. Employer-sponsored coverage is often received by a relatively advantaged group of Medicare beneficiaries; it generally provides the best reimbursement to providers and best healthcare access to beneficiaries. Self-purchased coverage, while typically more limited than employment-based coverage, provides better healthcare access than is available to those with Medicare only.

Access to care: We included three facets of access to care, based on three binary measures constructed by Porell and Miltiades using MCBS (Porell and Miltiades, 2001). The first indicated whether an enrollee faced a financial barrier to receiving care[2]; the second indicated whether an enrollee faced a "service" barrier to receiving care[3]; and the third indicated whether the enrollee was dissatisfied with care[4].

3.3.3 Control variables

We controlled for age (age 75-84 and age 85 or above, with age 65-74 as reference group); gender (male gender with women as reference group); and race (black race or "other" race, with whites as reference group).

4 Statistical methods

Bivariate analyses compared, across educational categories, means and proportions for self-rated health, ADL limitations, and chronic conditions, and for income, insurance supplemental to Medicare, and barriers to access to care. Consistent with the conceptual framework described above, we then estimated proportional odds models for our three health outcomes, all measured as ordinal response variables, by fitting a proportional odds model with a cumulative logit link for ordinal responses (McCullagh, 1980). The proportional odds model produces a common slope but separate intercepts for each of the cumulative logit equations of interest. Inherent in this model is the proportional odds assumption, which states that the cumulative odds ratio for any two values of the covariates is constant across response categories.

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2 If enrollee delayed getting care due to costs, including trouble getting needed health care or not seeing a doctor due to one or more cost-related reasons (had no money, cost was too high, services or supplies were not covered by insurance, doctor did not accept Medicare, doctor charged more than Medicare pays, could not find a doctor who accepted Medicaid, enrollee ineligible for public coverage but did not have private insurance).

3 If enrollee had trouble getting needed health care due to a lack of transportation to the doctor/hospital, difficulty getting an appointment, inability to get a timely appointment, unavailability of a doctor, or respondent was dissatisfied with the waiting time, the location of the doctor or the paperwork.

4 If enrollee was dissatisfied or very dissatisfied with at least one of four aspects of care received (information about diagnosis, quality of medical care received, doctor's concern for overall health, follow-up care after initial treatment); or dissatisfied with the time spent with the doctor, the doctor's thoroughness, the doctor's attitude and/or the doctor's competence.

For our three health outcomes, the first model in each series examined the relationship of educational attainment with that outcome, controlling for age, gender and race, and the interaction of age and gender with educational attainment; the second model added income; the third added insurance coverage; and the fourth added access to care. These four models were estimated for all three outcomes: chronic conditions, functional limitations and self-rated health. For the latter two outcomes, a fifth model was estimated, adding the chronic condition index and its interaction with education to our SES measures. For self-rated health, a sixth model was estimated, which also included functional limitations and its interaction with education.

All models accounted for the complex sample design[5]. Analyses were weighted to reflect census totals for national estimates.

5 Results

In bivariate analyses (Table 1), the magnitude of the association between education, typically completed by the third decade of life, and income and health status, some four to six decades later in the life course, was particularly noteworthy. The size of these associations was striking, considering the many individually unpredictable life course events that intervene, ranging from occupational shifts to marital transitions to changes in health status. While an association of education with income was expected, it is notable that completion of a college education almost assured that an individual would avoid poverty in late life (only 4.1% had incomes below the federal poverty line), while 30.3% of U.S. elders with less than high school education were in poverty. Beneficiaries with lower education levels were also much more likely to experience cost-related barriers to healthcare access and to lack any form of supplemental health insurance coverage.

The association of education with health was strongest for global health status. Approximately one-third (33.1%) of those without a high school diploma and 18.7% of high school graduates, versus only 11.2% of college graduates, reported poor or fair health status. Associations with functional status were also strong, with 35.1% of non-high-school graduates versus 18.0% of college graduates having impairment. Differences were smaller for mean number of chronic conditions (2.4 conditions for non-high-school graduates versus 2.1 for college graduates). The association of education with individual chronic conditions was particularly strong for diabetes, hypertension and lung disease – where the influence of behavioral factors such as diet and smoking over the decades were particularly important. Those with more

5 Since the MCBS is a stratified sample, using a multistage probability sampling design with three stages of sampling: primary sampling units (PSUs); ZIP codes within PSUs; and Medicare beneficiaries within ZIP-codes, PROC MULTILOG in SUDAAN was used.

Table 1: Health Status and Socioeconomic Characteristics by Educational Attainment

Variables	Total (N = 39,268) 100%	Less than High School (N = 14,992) 35.1%	High School (N = 12,899) 34.1%	Some College (N = 5,671) 15.2%	College Graduate (N = 5,706) 15.6%
Health Conditions					
Self-Rated Health*					
Excellent	17.2	11.5	16.9	21.7	26.3
Very Good	28.9	23.3	30.4	32.2	35.2
Good	31.8	32.1	34.1	30.6	27.4
Fair	16.5	24.0	14.2	12.0	8.8
Poor	5.6	9.1	4.5	3.6	2.4
ADL Limitations*					
None	73.2	64.9	76.3	76.8	82.0
1–2	18.7	23.4	17.1	16.7	13.4
3 or more	8.1	11.8	6.6	6.5	4.6
Mean # ADL Limits*	0.58	0.80	0.49	0.48	0.37
Chronic Conditions					
Arthritis*	58.6	63.2	58.0	57.7	50.5
Cancer*	31.0	26.4	30.5	35.5	38.3
Depression	5.0	5.1	5.2	5.1	4.5
Diabetes*	17.1	21.3	16.0	14.4	13.0
Heart Condition*	37.6	39.4	36.2	38.3	35.8
Hypertension*	55.9	59.9	55.8	55.1	48.2
Lung Disease*	13.7	15.9	13.0	13.4	10.5
Stroke*	10.1	11.8	9.6	9.4	7.8
Average # Chronic Cond.*	2.3	2.4	2.3	2.3	2.1
Socioeconomic Characteristics and health coverage					
Age*					
65–74 Years Old	54.7	48.2	57.6	58.3	59.8
75–84 Years Old	36.0	39.4	34.8	34.2	32.9
85 or Older	9.3	12.4	7.7	7.6	7.4
Gender*					
Female	57.5	58.0	63.5	58.2	42.4
Male	42.5	42.0	36.5	41.8	57.6
Race*					
White	88.0	79.2	92.6	93.1	93.0
Black	8.0	14.3	5.0	4.9	3.8
Other	3.9	6.5	2.4	2.1	3.2
Income as % Poverty*					
< 100% FPL	16.0	30.3	10.9	6.6	4.1
100% – < 200% FPL	33.3	44.5	35.4	24.3	12.6
200% – < 400% FPL	33.5	21.1	41.2	43.4	35.3
> 400% FPL	17.1	4.1	12.6	25.7	48.0
Supplemental Insurance*					
Medicare Only	9.4	14.6	7.6	6.5	4.7
Medicare + Medicaid	11.4	23.8	5.9	4.4	2.8
Medicare + Private Ins.	79.2	61.7	86.6	89.1	92.6
Access To Care					
High Costs*	7.0	10.1	5.7	5.8	3.8
Service Availability	11.1	11.0	10.8	11.9	11.6
Dissatisfaction*	12.9	11.9	12.6	14.3	14.3

* $p < .05$

education were actually more likely to report a history of cancer; it is not clear whether this represents a higher rate of detection of cancers that were successfully treated, or if less educated cancer patients had higher mortality rates, resulting in selective survivorship (Beckett, 2000; Robert and House, 1994).

These bivariate results suggest that health differences by education level are larger for functional and global measures of health status than for specific medical conditions, perhaps because advantages associated with education buffer the pathways from disease to function and to perceived health. The large income differences between educational groups suggest the need to examine to what extent the education/health association can be explained by income differences, as we explore in the multivariate analysis.

5.1 Regression results

Chronic conditions: As expected, education had a significant effect on the odds of having an additional chronic condition (Table 2a). Controlling for income reduced the education/health association, but the size of the reduction in this association was relatively modest. Further adjusting for supplemental health insurance coverage and healthcare access barriers had relatively little further impact on this relationship. Adjusting for these covariates made the biggest difference for younger women without a high school degree, reducing the odds ratio for this group from 1.87 to 1.57 relative to college graduates. The negative effect of not completing high school was slightly lower for men, and it diminished at older ages, i.e., among the middle old (age 76 to 85) and very old (above age 85). For high school graduates and those with some college, adjusting for coverage and access did not affect the education/health association. Thus, the effect of education on having an additional chronic condition was partially mediated through its effect on income, but only to a modest extent, and not mediated significantly at all through contemporaneous measures of supplemental health insurance and access to care. This suggests that the effect of education on having an additional chronic condition is more likely due to factors such as health behaviors, exposures and stress, or to healthcare access earlier in the life course, and not to a lack of health insurance or barriers to accessing care in late life.

It should be noted that the odds ratio for the effect of supplemental coverage, through Medicaid or private purchase, on number of chronic conditions was positive and significant. This is probably because Medicaid status serves as a proxy for those with the lowest SES, net of education and income, and because those with more health problems more actively seek out supplemental coverage.

Functional impairment: As expected, education was associated with the odds of having an additional functional limitation (Table 2b). The odds were highest for beneficiaries without a high school degree; lacking a degree had a greater effect on the odds of having an additional functional limitation than on the odds of having

Table 2a: Number of Chronic Conditions

	Model a1	Model a2	Model a3	Model a4
Education[a]				
Less than High School	1.87*	1.64*	1.55*	1.57*
High School	1.25*	1.16*	1.15*	1.17*
Some College	1.31*	1.26*	1.25*	1.27*
Male	1.01	1.03	1.03	1.05
Male*Education[b]				
Less than High School	0.74*	0.75*	0.79*	0.79*
High School	1.00	0.99	1.01	1.01
Some College	1.06	1.05	1.07	1.06
Age[c]				
75–84	1.76*	1.73*	1.72*	1.74*
85+	2.02*	1.97*	1.98*	2.05*
Age*Education[d]				
75–84 less than HS	0.76*	0.77*	0.77*	0.78*
85+ less than HS	0.66*	0.67*	0.66*	0.66*
75–84 HS	0.89	0.90	0.90	0.90
85+ HS	0.91	0.91	0.91	0.91
75-84 some college	0.88	0.88	0.89	0.88
85+ some college	0.78*	0.77*	0.77*	0.76*
Income as % Poverty[e]				
< 100% FPL		1.39*	1.14*	1.11*
100% – < 200% FPL		1.26*	1.26*	1.23*
200% – < 400% FPL		1.13*	1.14*	1.13*
Supplemental Insurance[f]				
Medicare + Medicaid			2.50*	2.54*
Medicare + Private Ins.			1.37*	1.43*
Access to Care				
High Costs				1.39*
Service Availability				1.46*
Dissatisfaction				1.37*
Nagelkerke Pseudo R^2	0.0271	0.0296	0.0416	0.0542

a: reference group is college graduates; b: interaction of male dummy with education dummies. c: reference group is age 65–74. d: interaction of age dummies with education dummies. e: reference group is income > 400% of federal poverty line (FPL) f: reference group is Medicare only. All models also control for race.

*$p < 0.05$

an additional chronic illness. This pattern is consistent with the supposition that the multiple resources conferred by education, acting over the life course, buffer the impact of disease on functional impairment. It is also possible that chronic conditions that exist may be more likely to be diagnosed in individuals with educational advantages, as suggested by the positive association with a diagnosis of ever having cancer. Odds ratios for an additional functional limitation were marginally higher for those with some college than for high school graduates, but the 95% confidence intervals overlapped. The effect of education on the odds of an additional functional limitation diminished at older ages, among the middle old (age 76 to 85) and very old (above age 85).

Table 2b: Number of ADL Limitations

	Model b1	Model b2	Model b3	Model b4	Model b5
Education[a]					
Less than High School	2.64*	1.92*	1.75*	1.81*	1.59*
High School	1.34*	1.13	1.12	1.16	1.10
Some College	1.41*	1.30*	1.29*	1.31*	1.16
Male	0.73*	0.77*	0.77*	0.79*	0.76*
Male*Education[b]					
Less than High School	0.90	0.92	0.96	0.95	1.04
High School	1.01	1.01	1.01	1.01	1.03
Some College	1.01	1.01	1.01	1.00	0.99
Age[c]					
75–84	1.93*	1.87*	1.87*	1.94*	1.67*
85+	5.25*	4.98*	5.03*	5.53*	4.83*
Age*Education[d]					
75–84 less than HS	0.80*	0.81*	0.84*	0.85*	0.93
85+ less than HS	0.61*	0.61*	0.63*	0.64*	0.73*
75-84 HS	1.00	1.01	1.03	1.03	1.09
85+ HS	0.88	0.87	0.88	0.87	0.91
75-84 some college	0.89	0.88	0.89	0.88	0.92
85+ some college	0.76*	0.74*	0.75*	0.74*	0.82
Income as % Poverty[e]					
< 100% FPL		2.14*	1.55*	1.47*	1.45*
100% – < 200% FPL		1.67*	1.59*	1.51*	1.42*
200% – < 400% FPL		1.23*	1.25*	1.22*	1.18*
Supplemental Insurance[f]					
Medicare + Medicaid			2.01*	2.09*	1.59*
Medicare + Private Ins.			0.92	1.01	0.89
Access to Care					
High Costs				1.82*	1.68*
Service Availability				1.80*	1.64*
Dissatisfaction				1.77*	1.65*
# Chronic Conditions					
# of Chronic Conditions*Education[g]					1.55*
Less than High School					0.99
High School					0.99
Some College					1.01
Nagelkerke Pseudo R^2	0.0789	0.0884	0.0986	0.1276	0.1937

a: reference group is college graduates; b: interaction of male dummy with education dummies. c: reference group is age 65–74. d: interaction of age dummies with education dummies. e: reference group is income > 400% of federal poverty line (FPL) f: reference group is Medicare only. g: interaction of # of chronic conditions with education dummies. All models also control for race. *$p < 0.05$

Adjusting for income reduced the odds ratio for lacking a high school degree by over a third, for high school graduates by almost 20%, and for those with some college by almost 10%. Nonetheless, education affected the odds of an additional functional limitation, even controlling for income. Adjusting for supplemental insurance mediated, or more likely confounded, the estimated effect of not having a high school degree, or of having income below 200% of the federal poverty level (FPL), on the odds of having an additional functional impairment. Adjusting for supplemental insurance reduced the odds of an additional functional limitation among those without a high school degree by 10% and those with income between

100% and 200% of the FPL by about 5%. It reduced the odds of an additional functional impairment among those with income below the FPL by over one-third. The odds ratio for the effect of supplemental Medicaid on the number of functional limitations was large and significant, which may again be due to Medicaid serving as a proxy for having the lowest SES, net of education and income.

Controlling for barriers to accessing care strengthened the estimated effect of low education and supplemental insurance on the odds of having an additional functional limitation. Controlling for barriers to access partially mediated the effect of low income on the odds of having an additional functional limitation; it was associated with a 5% reduction in the odds ratios. All three measures of barriers to access directly affected the odds of having an additional functional limitation, increasing the odds of an additional limitation, as hypothesized. Those encountering barriers to care may not receive timely primary or secondary preventive services. Alternatively, it may be that only those with medical conditions and functional limitations who were in need of care were at risk for encountering barriers to access.

Perhaps the most interesting finding was the effect of the number of chronic conditions and its interaction with education on functional impairment, and the role of the number of chronic conditions in mediating the effects of education, income, supplemental insurance, and access to care. As expected, an additional chronic condition increased the odds of an additional functional impairment. In addition to its direct effect, the number of chronic conditions mediated the effects of education and income, reducing the odds ratios for lower education levels by 6%-14% and the odds ratios for lower income by 1%-6%. This suggests that one pathway through which lower levels of education and income lead to greater odds of functional impairment is by increasing the odds of additional chronic conditions. These and other results discussed above suggest that education may affect functional outcomes through multiple pathways: reducing the prevalence of disease states and buffering their impact on function. However, in interacting the number of chronic conditions with education, we found no subgroup effects.

Self-rated health: Education, as expected, was strongly associated with the odds of having poorer self-rated health (Table 2c). Less-educated beneficiaries had substantially greater odds of having poorer self-rated health than college graduates. The odds were highest for beneficiaries without a high school degree. In fact, the odds of a poorer health rating were inversely related to educational attainment; they increased as education decreased, with a "dose-response" relationship, even after controlling for income, supplemental insurance and access to care. The effects of education and income were similar. Income partially mediated the effects of education, reducing the odds ratio for high school graduates by 20% and for those with some college by 13%. Nonetheless, the effects of education remained strong, even controlling for income, supporting the view that the influence of early educational attainment on health many years later is pervasive, probably operat-

Table 2c: Self Rated Health

	Model c1	Model c2	Model c3	Model c4	Model c5	Model c6
Education[a]						
Less than High School	3.64*	2.60*	2.41*	2.48*	2.33*	2.49*
High School	1.85*	1.55*	1.54*	1.59*	1.62*	1.70*
Some College	1.42*	1.30*	1.29*	1.31*	1.31*	1.35*
Male	1.02	1.07	1.07	1.11*	1.08	1.13*
Male*Education[b]						
Less than High School	0.86*	0.90	0.95	0.92	1.02	1.04
High School	0.94	0.96	0.97	0.96	0.96	0.97
Some College	1.01	1.03	1.03	1.02	1.01	1.04
Age[c]						
75–84	1.36*	1.31*	1.31*	1.33*	1.08	1.01
85+	1.73*	1.63*	1.63*	1.72*	1.33*	0.89
Age*Education[d]						
75–84 less than HS	0.80*	0.81*	0.83*	0.84*	0.91	0.89
85+ less than HS	0.52*	0.52*	0.54*	0.54*	0.61*	0.63*
75–84 HS	0.94	0.94	0.95	0.96	1.01	0.99
85+ HS	0.72*	0.72*	0.73*	0.71*	0.73*	0.75*
75–84 some college	0.87	0.86*	0.87	0.86*	0.90	0.91
85+ some college	0.82	0.80*	0.81	0.78*	0.88	0.95
Income as % Poverty[e]						
< 100% FPL		2.28*	1.76*	1.70*	1.70*	1.63*
100% – < 200% FPL		1.70*	1.64*	1.58*	1.51*	1.43*
200% – < 400% FPL		1.24*	1.25*	1.23*	1.18*	1.16*
Supplemental Insurance[f]						
Medicare + Medicaid			1.96*	2.02*	1.47*	1.29*
Medicare + Private Ins.			0.99	1.05	0.92	0.94
Access to Care						
High Costs				1.74*	1.60*	1.44*
Service Availability				1.40*	1.23*	1.10*
Dissatisfaction				1.69*	1.56*	1.42*
# Chronic Conditions					1.70*	1.61*
# of Chronic Conditions*Education[g]						
Less than High School					0.98	0.95
High School					0.97	0.97
Some College					0.96	0.94
# of ADLs						1.78*
# ADLs*Education[h]						
Less than High School						0.90*
High School						0.93
Some College						0.98
Nagelkerke Pseudo R^2	0.0651	0.0807	0.0898	0.1121	0.2312	0.2951

a: reference group is college graduates; b: interaction of male dummy with education dummies. c: reference group is age 65–74. d: interaction of age dummies with education dummies. e: reference group is income > 400% of federal poverty line (FPL) f: reference group is Medicare only. g: interaction of # of chronic conditions with education dummies. h: interaction of # of ADLs with education dummies.

All models also control for race. *$p < 0.05$

ing through multiple pathways; is not limited to a "threshold effect" such as that represented by high school graduation; and is mediated only in part by the higher

incomes that the better-educated go on to receive. However, the effect of education does diminish at older ages, among the middle old (age 76 to 85) and particularly the very old (above age 85).

Medicaid increased the odds of poorer self-rated health, perhaps again serving as a proxy for low SES and high health need. Controlling for Medicaid reduced the odds of poorer health among those without a high school degree by 8% and for those below the poverty line by 30%. Barriers to accessing care increased the odds of poorer self-rated health, as hypothesized. Holding constant barriers to accessing care increased the odds ratios for education.

The most interesting findings were the direct effects of the number of chronic conditions and functional limitations on self-rated health, their interaction with education, and especially their role in mediating the effects of income, supplemental insurance, access to care, and in a model without the health/education interaction terms, education. As expected, an additional chronic condition or functional limitation increased the odds of poorer self-rated health. Interacting education with physical function indicated that the effect of an additional functional limitation on the odds of poorer self-rated health was weakened in the subgroup without a high school degree, perhaps due to a ceiling effect. Adjusting for number of chronic conditions and its interaction with education reduced the odds ratios for the direct effect of less than a high school education by 6% and the odds ratios for the effects of lower income by up to 5%. Adjusting for number of functional limitations and its interaction with education increased the odds ratios for the direct effect of education, but decreased the odds ratios for income. Thus, one pathway through which lower levels of education and income lead to poorer self-rated health is by increasing the odds of an additional chronic condition or functional limitation. However, this represents only part of the process by which education affects self-rated health outcomes. As with functional status, results are consistent with the suggestion that education affects distal health outcomes through multiple pathways – decreasing not only the prevalence of disease states but their impact on other aspects of health.

6 Discussion

Our results show that the relationship between education and health status in late life remains strong, even after controlling for income, supplemental health insurance, and access to care, across multiple domains of health. We consider three domains of health: chronic medical conditions, functional limitations, and self-rated health. Our results support the conclusion that, across all three domains of health, the influence of early educational attainment on health in late life is large, probably operating through multiple pathways, and is mediated only in part by the higher incomes that the better-educated go on to receive.

In our conceptual framework, since educational attainment remains largely fixed after the third decade of life, we modeled it as causally prior to income in late life. We hypothesized that the effects of education on health are partially mediated by income, that the effects of education and income on health are partially mediated by supplemental insurance, and that supplemental insurance impacts health through its influence on access to care. These hypotheses were supported to some modest degree. For all three domains of health, some of the effects of education are mediated through income, but income explains only a relatively small part of the education/health relationship, and contemporaneous supplemental insurance and access to care seem to play little explanatory role. Providing adequate insurance and access to care may perhaps be necessary to reducing disparities by education level in late life health, but they do not appear to be sufficient. At least among the elderly, our findings suggest that providing insurance and eliminating barriers to care in late life are not enough, though with the important caveat that the quality of supplemental coverage varies widely and we did not adjust for plan quality. This is not surprising, since socioeconomic disparities in health outcomes are large, even in countries with universal healthcare coverage such as England (Ettner, 1996; Hurowitz, 1993). It suggests that health insurance reforms alone may not eliminate socioeconomic disparities in health (Ettner, 1996).

The conceptual framework serves a heuristic purpose in focusing attention on the distinct relationships of disparate aspects of health, and suggests that interventions to reduce disparities can address multiple targets. For example, policies focused on reducing the onset of chronic conditions, and on treatments to slow their progression, can have spillover effects on reducing debilitating and often expensive functional impairments, as well as overall health. Collectively, these results suggest that the magnitude of the association between education and multiple domains of late life health is impressive; that these effects on various aspects of health are interrelated; that these effects on health are only partially mediated through the effect of education on late life income; and that insurance and access to care, at least in late life, are not the main conduit through which education (and income) affect health. A wide range of alternative hypotheses have been put forth to understand the pathways through which schooling affects late life health. Several of these are consistent with the pattern of results we have found.

Individual characteristics that may explain the correlation between education and health include time preference, knowledge, training, differences in occupational choices, and employee benefits (such as health insurance coverage) associated with those choices, as well as many other individual characteristics. Better-educated individuals may be more future-oriented, with a lower discount rate, and invest more in education and future health. This may in part reflect their selection into education (Berger and Leigh, 1989; Deaton, 2002); however, the process of education may also affect these characteristics, and provide access to knowledge and health literacy that

may improve self-management and adherence to health regimens (Deaton, 2002; Goldman and Smith, 2002). A challenging topic for life course research, beyond the scope of this paper, involves fine-grained analyses over a substantial part of the life course (particularly midlife) that can test whether differences in health habits and use of preventive care explain the education gradient in health. If education also improves health literacy, its absence may hinder a person's ability to respond to health messages, assess the validity of competing sources of health information, and negotiate the complex U.S. healthcare system, now further complicated by the complexities of Medicare Part D prescription drug coverage. If education is correlated with lifestyle, due to time preference, knowledge or training, the less-educated may be more exposed to a wide range of risk factors, from smoking to fast-food to obesity. Finally, since there is a close link between the level of social deprivation and children's performance in school, education may be a marker of family background, and a crucial determinant of where "people end up in adult life" (Marmot, 2003b). A lower education level may be correlated with a higher level of psychosocial stressors, which adversely affects health (Marmot, 2003a).

This study does have limitations which should be noted. The most important is that, since the data used for this study is a nationally representative sample of the U.S. Medicare population age 65 or above, we cannot examine the cumulative effects of education on health over the lifespan. We can only examine whether health disparities remain in late life. To assess whether poor health among the less educated in midlife sets the stage for health disparities in late life, nationally representative data on health status and SES at midlife are needed. Nonetheless, the finding that health disparities by educational attainment remain in late life suggests a need for healthcare reform. While insurance coverage and access to care in late life do not appear to explain the educational gradient in health, perhaps improved healthcare coverage in mid-life, when chronic conditions first develop, could buffer late life educational disparities in health. Nonetheless, within European countries with universal health insurance coverage, disparities in self-assessed health by education and income persist in midlife, among men and women aged 25–69 years (Kunst et al., 2005).

Assessing whether universal health insurance coverage would fundamentally alter the relationship of education and income with health may be informed by examining the European model. Among the OECD nations, Switzerland's healthcare system is closest to that in the U.S. Switzerland has the second-most-expensive healthcare system in the world, surpassed only by the U.S. Moreover, while healthcare insurance has been compulsory in Switzerland since 1996 (Shaha, 2004), Switzerland was second only to the United States in the share of health expenditures paid for by the private sector. In 2003, 41.5% of health expenditures in Switzerland were by the private sector, as compared to 55.4% in the United States (Organization for Economic Cooperation and Development 2006). Basic health insurance and

supplementary health insurance are provided by private insurance companies in Switzerland (Leu et al., 2009). Beneficiaries with the means can purchase "better" coverage, while premiums for low income beneficiaries are subsidized by national/ cantonal funds (Schoenenberger and Stuck, 2006).

Nonetheless, in a study of morbidity differences by education level in 11 countries from northern, western and southern parts of Europe, inequalities were relatively large in Sweden, Norway and Denmark, they were intermediate in Finland, Great Britain, France and Italy, and they were relatively small in Spain, Switzerland and Germany (Cavelaars et al., 1998). In one of the few studies of health disparities in industrialized nations that included the U.S. (Kunst, Geurts, and van den Berg, 1995), disparities in self-assessed health by education level in the U.S. were particularly high. Scandinavian countries and the Netherlands did not have relatively small inequalities in morbidity by education level despite egalitarian socioeconomic public policies (Cavelaars et al., 1998). Using chronic conditions and physical function as the measures of health, health differences by wealth tertile were smallest in Austria, Switzerland, and southern European countries, larger in Scandinavian countries, Germany, the Netherlands and France and largest in the United States and England (Avendano et al., 2009).

Using income as the measure of SES and self-assessed health as the measure of health, Doorslaer (1997) found a fairly clear association between income inequality and health inequality ($r = -0.87$). The U.S. followed by the United Kingdom had the greatest level of health inequality; Spain followed by Switzerland and then the Netherlands had a medium level of inequality in health; West Germany followed by Finland had a medium to low level of health inequality, and Eastern Germany followed by Sweden had the lowest level of health inequality (Doorslaer et al., 1997). Thus, inequality in self-assessed health within a country appears to be more closely correlated with income inequality than with inequality in education.

This suggests that late life inequality results from life course events and social policies, not only as an inevitable result of cumulative advantage processes. Education can buffer the impact of economic outcomes on health, but the relationship is also shaped by public policy choices and societal institutions. Publicly funded healthcare, for the elderly and particularly at midlife, could be a critical buffering variable (Crystal and Shea, 2002). However, social policies may be even more important, such as those that discourage smoking or encourage improved nutrition, exercise, and reduction of obesity. Further, health insurance coverage alone may not be sufficient if healthcare systems do not cover and proactively encourage consistent management of chronic conditions and use of preventive services. This issue will be a challenge in the U.S. in coming years given the trend to increase cost-sharing requirements of health insurance, which can disproportionately discourage use of elective (e.g., preventive) services by disadvantaged subgroups.

Perhaps most important is the development of better models for managing chronic diseases among those with less education. In addressing these issues, key questions remain. How does the secular trend in education levels impact on late life health? Is it the absolute or relative level of education that matters? Can health disparities by educational attainment be reduced through modifiable factors? These questions suggest the importance of more research that examines, over the life course, the interactions among economic resources, healthcare access, and health status.

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Appendix: Number of ADL Limitations and Self Rated health

	Model b5	Model b5a	Model c5	Model c5a	Model c6	Model c6a
Education[a]						
Less than High School	1.59*	1.54*	2.33*	2.19*	2.49*	2.13*
High School	1.10	1.06	1.62*	1.52*	1.70*	1.55*
Some College	1.16	1.18	1.31*	1.19*	1.35*	1.18*
Male	0.76*	0.81*	1.08	1.09	1.13*	1.12*
Male*Education[b]						
Less than High School	1.04	0.98	1.02	1.00	1.04	1.06
High School	1.03	1.00	0.96	0.96	0.97	0.97
Some College	0.99	0.97	1.01	1.01	1.04	1.04
Age[c]						
75–84	1.67*	1.73*	1.08	1.13*	1.01	1.06
85+	4.83*	4.93*	1.33*	1.40*	0.89	1.00
Age*Education[d]						
75–84 less than HS	0.93	0.91	0.91	0.90	0.89	0.85*
85+ less than HS	0.73*	0.74*	0.61*	0.60*	0.63*	0.56*
75–84 HS	1.09	1.09	1.01	0.99	0.99	0.96
85+ HS	0.91	0.94	0.73*	0.72*	0.75*	0.70*
75-84 some college	0.92	0.92	0.90	0.89	0.91	0.89
85+ some college	0.82	0.84	0.88	0.87	0.95	0.91
Income as % Poverty[e]						
< 100% FPL	1.45*	1.39*	1.70*	1.66*	1.63*	1.61*
100% – < 200% FPL	1.42*	1.38*	1.51*	1.47*	1.43*	1.41*
200% – < 400% FPL	1.18*	1.16*	1.18*	1.17*	1.16*	1.15*
Supplemental Insurance[f]						
Medicare + Medicaid	1.59*	1.55*	1.47*	1.43*	1.29*	1.24*
Medicare + Private Ins.	0.89	0.90*	0.92	0.93	0.94	0.94
Access to Care						
High Costs	1.68*	1.67*	1.60*	1.59*	1.43*	1.43*
Service Availability	1.64*	1.64*	1.23*	1.23*	1.09*	1.09*
Dissatisfaction	1.65*	1.65*	1.56*	1.55*	1.41*	1.41*
# Chronic Conditions	1.55*		1.70*		1.61*	
# of Chronic Conditions*Education[g]						
Less than High School	0.99		0.98		0.95	
High School	0.99		0.97		0.97	
Some College	1.01		0.96		0.94	
Chronic Conditions						
Arthritis		2.18*		1.71*		1.55*
Cancer		1.08*		1.20*		1.20*
Depression		1.67*		2.12*		1.91*
Diabetes		1.71*		1.87*		1.71*
Heart Condition		1.39*		1.80*		1.74*
Hypertension		1.18*		1.47*		1.46*
Lung Disease		1.67*		2.08*		1.94*
Stroke		2.51*		1.82*		1.39*
# of ADLs					1.78*	1.64*
# ADLs*Education[h]						
Less than High School					0.90*	
High School					0.93	
Some College					0.98	

a: reference group is college graduates. b: interaction of male dummy with education dummies. c: reference group is age 65–74. d: interaction of age dummies with education dummies. e: reference group is income>400% of federal poverty line (FPL). f: reference group is Medicare only. g: interaction of # of chronic conditions with education dummies. h: interaction of # of ADLs with education dummies.

All models also control for race. *$p < 0.05$