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Trajectories of Functional Health: The 'Long Arm' of Childhood Health and Socioeconomic Factors*

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ABSTRACT

Few studies have examined trajectories of functional health status *as such* or estimated the extent to which they are influenced by childhood health and socioeconomic conditions. This study examines how circumstances associated with early life may shape the level and progression of functional limitations among adults at or near retirement. Employing data from the Health and Retirement Study (HRS), it estimates Latent Growth Curve models (LGM) of functional limitation. The results demonstrate that functional health trajectories in old age continue to be shaped by childhood health and socioeconomic circumstances. Poor childhood health and disadvantaged social origins are associated with both more functional limitations at baseline and higher rates of increase over time. This association is net of baseline adult chronic disease and socioeconomic status. While both childhood and adult factors influence the baseline level of functional limitation, only childhood health and SES are associated with that rate of change in limitations over time.

INTRODUCTION

The health of individuals is not temporally static, nor can it be divorced from the cumulative impacts of lived experience, which include exposures associated with individual placement within social and economic hierarchies. Demographers and other social scientists are beginning to investigate the myriad ways in which adult health, physical functioning, and mortality are linked to early life exposures with the goal of assessing what Hayward and Gorman have called 'the long arm of childhood' (Hayward and Gorman 2004). This literature suggests that substantial gains in understanding adult health outcomes can be made from better knowledge of their determinants over the life course. It also suggests that the broad parameters of health trajectories and socioeconomic disparities therein may, in part, be forged very early in life, as unhealthy and socioeconomically disadvantaged children become unhealthy and socioeconomically disadvantaged adults. This study examines functional health status in older Americans with the goal of better understanding the relative influence of early- and later-life health and socioeconomic factors on trajectories of functional limitation.

EARLY LIFE INFLUENCES ON ADULT HEALTH

Childhood Socioeconomic Circumstances

A growing body of research has documented connections between the social and economic characteristics of family of origin and adult health and mortality. Such studies have found that those from disadvantaged backgrounds have more health-related risk factors (Blane et al. 1996) and increased risk of numerous chronic diseases, including depression (Gilman et al. 2002), cardiovascular disease (Notkola et al. 1985; Wannamethee et al. 1996), and stroke (Hart, Hole, and Davey Smith 2000). Those from disadvantaged social backgrounds also tend to have worse self-rated health (Rahkonen, Lahelma, and Huuhka 1997), and higher overall rates of morbidity (Kuh and Wadsworth 1993) and mortality (Notkola et al. 1985; Davey Smith et al. 1997, 1998; Peck 1994). However, a few studies have failed to confirm an important role for childhood SES in determining adult health (Lynch et al. 1994), or limit its role to that of an upstream determinant of the proximal, and presumably theoretically more important, adult socioeconomic position (most notably in the Whitehall II study of British civil servants) (Marmot et al. 2001).

There is also debate about the relative influence of early life and adult socioeconomic circumstances on adult health. The extant literature suggests that the relative contribution of early life and adult socioeconomic status likely varies by the underlying disease process. In terms of mortality, deaths due to accidents, violence, and lung cancer are most strongly associated with *adult* socioeconomic factors while deaths due to stroke and stomach cancer are more strongly linked to *childhood* economic conditions (Davey Smith et al. 1998). Mortality from heart and respiratory diseases are associated with both childhood and adult factors (Davey Smith et al. 1998).

Childhood Health

As with childhood SES, there is an extensive body of research on the relationship between childhood and various adult health outcomes. Much of this research is based on the use of height as a proxy of early life health and nutrition (Floud, Wachter, and Gregory 1990). Such studies have typically found a negative association between achieved adult height and adult morbidity and mortality (Fogel and Costa 1997; Yarnell et al. 1992).

A few studies have directly investigated the relationship between childhood and adult health using various population-based surveys. Among these are a very small number of prospective investigations using the British cohort studies. In the 1946 British cohort study, Colley and colleagues (1973, 1976) found that lower respiratory illness in infancy was associated with increased symptoms of chronic obstructive pulmonary disease (COPD) (Colley, Douglas, and Reid 1973). In addition, serious illness between ages 5-24 was associated with poor health at age 36 (Kuh and Wadsworth 1993). Other studies have investigated this relationship using retrospective reports of childhood health in US-population-based studies. Using the Health and Retirement Study (HRS), Blackwell, Hayward, and Crimmins (2001) found a significant positive association between serious infectious disease in childhood and various adult chronic diseases including cardiovascular disease, arthritis/rheumatism, cancer, and lung conditions. Recently, Haas (2004) found poor childhood health to be associated with poor self-rated health, work-limiting disability, and chronic disease using the Panel Study of Income Dynamics (PSID). In addition, poor childhood health was associated with increased risk of a decline in self-rated health over a two-year period (Haas 2004).

Despite growing attention, there are a number of important gaps in the literature on early life influences on adult health. A major limitation of previous research is that very little work to date has investigated the influence of childhood socioeconomic circumstances on functional health status in adulthood. A recent exception is the work of Lou and Waite (2005), which found that those from well-off families had significantly fewer functional limitations in later life compared to those from disadvantaged families. This difference remained after controlling for adult SES. They also presented compelling evidence that the effect of SES tends to accumulate over the life course and that the adverse consequences of disadvantageous childhood SES can be ameliorated by upward social mobility. Despite its contributions, a major limitation of their work, as well as most previous studies to date, is that it only investigated adult health status in cross-section. Few studies have examined health trajectories *as such*. This study attempts to fill this empirical gap by estimating the impact of early life circumstances on trajectories of functional limitations in older adults and the relative contribution of early- and later-life factors in shaping those trajectories.

Another limitation is that although childhood health is often assumed to be an important mediating factor in the childhood SES and adult health relationship, few studies have investigated the two simultaneously. Lou and Waite (2005) found an association between poor childhood health and a variety of poor adult health outcomes including self-rated health, functional limitations, chronic conditions, and depressive symptoms. This association held after adjusting for childhood and adult socioeconomic status. Again, they cannot say how early life factors influence patterns of change in functional status over time because they looked only at functional limitations in cross-section.

There is distinct reason to suspect that childhood circumstances may influence adult trajectories of functional limitation. First, the research discussed above has shown health and socioeconomic status in childhood to be associated with adult chronic disease (Blackwell, Hayward, and Crimmins 2001; Gilman et al. 2002). Chronic conditions such as arthritis, stroke, diabetes, heart disease, and depression are among the most important determinants of functional limitation and disability in adults. Therefore, it is to be expected that anything that increases the risk of chronic disease will also adversely impact functional health. Through this pathway, as chronic health conditions tend to worsen over time (and therefore become more debilitating) and as co-morbidities tend to accumulate, it is likely that those who experienced poor health and disadvantaged socioeconomic circumstances in childhood will experience steeper trajectories in functional limitations than their healthy and more advantaged peers. Another pathway in which childhood health and socioeconomic status may influence adult functional status is through impaired adult socioeconomic attainment. While there is a voluminous literature documenting the processes by which childhood economic conditions structure adult economic attainment (Sewell and Hauser 1975), more recent research has shown that poor childhood health also exerts a significant negative impact on adult educational and occupational attainment, earnings, and wealth (Haas 2006; Case, Fertig, and Paxson 2005; Black, Devereux, and Salvanes 2005). Given the well-established role of adult SES as a determinant of health status, to the extent that poor childhood health and disadvantaged childhood socioeconomic conditions lead to diminished adult socioeconomic attainment, they are also likely to indirectly lead to steeper trajectories of functional limitation.

The present study overcomes these limitations by using a unique combination of retrospective and prospective data from the Health and Retirement Study (HRS) and latent growth curve models (LGMs) to estimate the relative impact of early-life and adult health and social circumstances on functional health trajectories.

DATA

The Health and Retirement Study (HRS) is a long-term panel study of near-elderly Americans begun in 1992 designed to investigate the economic and health transitions associated with retirement (Juster and Suzman 1995). Follow-up takes place every second year. The original HRS cohort was composed of those born between 1931 and 1941 and their spouses. This study utilizes data on the original HRS cohort members because it now includes six waves of data. Because childhood health and some aspects of socioeconomic background were not assessed until the fourth wave of data collection (1998), the present analysis drops those lost to follow-up before then (mostly due to mortality) resulting in an analytic sample of 10,961. All other missing data is dealt with using multiple imputation. Given that most of the covariates are based on reports from the initial wave (1992), there is relatively little missing data on these variables. Most missing data comes from the functional limitations measures with the number of missing cases becoming progressively larger with each subsequent wave due to sample attrition. While 866 cases (7.9%) were missing functional limitations in 1994, 1862 cases (17%) were missing 2002 reports of functional limitations.

MEASUREMENT

Functional Limitations

The measurement of functional health status is conceptually complex because it represents the nexus of physical capacity, the demands of particular social roles, and characteristics of the physical environment that may facilitate or impede functioning. Thus functional limitation reflects both underlying physical ability and the influence of the social and physical environment. For example, about half of the recent decline in the number of persons dependent upon personal care is due to increased use of assistive technology rather than improved physical capacity (Freedman et al. 2006). The difficulty lies in constructing measures that assess underlying ability while minimizing the influence of the social and physical environment. The HRS has three candidate scales of functional health status. Two of these are Activities of Daily Living (ADLs) and Instrumental Activities of Daily Living (IADLs). ADLs and IADLs assess the ability to perform a series of tasks that are essential to independent living. ADLs evaluate self-care tasks such as bathing, dressing, and eating, while IADLs assess more cognitively complex tasks such as meal preparation, shopping, and managing one's finances. One problem with ADLs and IADLs is that the level of impairment they measure is actually quite severe. Not being able to bathe oneself represents a significantly higher level of disability than not being able to walk several blocks or climb stairs. Therefore, ADLs and IADLs are less appropriate for assessing functional status among the relatively younger, healthier HRS sample. Another issue is that ADLs and IADLs measure the extent to which an individual has the ability to live and function independently. They are thus, by design, more sensitive to the use of assistive technology, personal care, and the social and physical environment (Clark, Stump, and Wolinsky 1997; Verbrugge and Jette 1994). For example, for a male in a marriage characterized by traditional gender roles, it may not be significant to his overall functioning if he is unable to cook for himself as this task is generally not critical to his social location. Conversely, if his spouse is unable to perform the same task, then this would represent a significant limitation in her ability to fulfill an important gendered social role.

The third measure of functional health status in the HRS is functional limitation. Most notably associated with Nagi (1969) and Rosow and Breslau (1966), functional limitations are based on reports as to whether a respondent because of a health condition has some difficulty performing the following physical tasks -

-Walking several blocks
-Walking one block
-Sitting for two hours
-Getting up from a chair after having sat for a while
-Climbing several flights of stairs
-Climbing a single flight of stairs
-Stooping, kneeling, or crouching
-Lifting or carrying 10 lbs.
-Picking up a dime off of a table
-Raising one's arms above one's shoulders
-Pushing or pulling large objects such as furniture

These tasks are indicators of general physical ability and are not associated with performing any particular social role. Unfortunately, some of these tasks are not independent of the built environment or the use of assistive technology and therefore are not solely a measure of physical ability. Thus it is important to keep in mind that this measure represents physical capacity net of the physical environment and the use of assistive technologies. A summary score potentially ranging from 0-11 is created by summing over all tasks. Chronbach's alpha for these indicators is 0.85 (Fonda and Herzog 2004). Previous research has investigated the dimensionality of functional health status measures and supports the use of a uni-dimensional measure (Wolinsky and Johnson 1992)

Functional limitations from waves 2-6 (1994-2002) are modeled in the analysis below. Functional limitations were assessed in 1992, however, changes in question wording make these reports incomparable with subsequent waves. The 1992 questions ask "how difficult is it for you to …?" while questions since the 1994 wave have asked "Do you have any difficulty …?" While this difference in wording may seem small, the change in the mean number of limitations between 1992 and 1994 is large enough to induce an improbable negative quadratic functional form over the entire period despite the fact that the growth in functional limitations after 1994 follows a clear positive curvilinear pattern.

Predictors of Health Trajectories

Childhood Health

The investigation of the effects of childhood health on later-life outcomes has been limited primarily by the scarcity of prospective life course data on both health and SES. Researchers must often find alternative ways of assessing these effects. The method used in this analysis is retrospective reports. In 1998, respondents were asked to “consider your health while you were growing up, from birth to age 16. Would you say that your health during that time was excellent, very good, good, fair, or poor?” Values of 4 (excellent) – 0 (poor) were assigned to these categories.

Previous research suggests that retrospective measures of childhood health perform reasonably well. It has been shown using data from the PSID and the HRS that retrospective reports of overall childhood health are reliably reported over time (polychoric correlation =0.6; Goodman-Kruskal gamma=0.6), especially when the measure was dichotomized into a good/very good/excellent vs. fair/poor comparison (tetrachoric correlation=0.7; Goodman-Kruskal gamma=0.9) (Haas 2004). Quality of measurement did not vary substantially by gender or age. However, those with higher levels of education were more consistent reporters of childhood health (Haas 2004). Retrospective reports were also correlated with birth weight, with low birth weight respondents reporting significantly worse childhood health (Haas 2004). Using the HRS, Elo (1998) demonstrated a high level of internal consistency between the report of general childhood health and reports of specific long-term health limitations in childhood.

Krall and colleagues (1988) compared retrospective self reports of childhood communicable diseases, accidents, hospitalizations, surgeries, and other illnesses against a series of physical exams and parental interviews in a birth cohort. Retrospective childhood health questionnaires administered at ages 30, 40, and 50 showed a very high level of accuracy (averaging 85% at age 50). Accidents and surgeries were recalled correctly 75% and 89% of the time at age 50, respectively. Reliability did not change much between ages 30 and 50, nor was recall accuracy correlated with education (Krall et al. 1988).

Childhood Socioeconomic Circumstances

Parental education is measured as a set of 4 dummy categories each for mother and father. These categories include less than high school (0-11 years), high school graduates (reference group), high school and above (12+ years), and a missing category. In addition, in 1998 respondents were asked a series of questions designed to assess their family's SES retrospectively. Among these are an overall assessment of their childhood SES from which an indicator of whether the respondent's family was poor (1=yes; 0=no) was created. Furthermore, there were indicators for whether the family ever moved due to financial problems (1=yes; 0=no), whether their father was present in the household (1=yes; 0=no), and whether their father ever experienced a period of unemployment during the respondent's childhood (1=yes; 0=no). Previous research has confirmed the quality of retrospective reports of childhood SES (Krieger et al. 1998).

Adult Socioeconomic Status

Multiple measures of adult socioeconomic status at wave I (1992) are included. These include educational attainment measured as years of completed schooling, as well as total household income, and net household assets, both of which are measured on a log scale.

Chronic Health Conditions and Health-Related Risk Factors

A large body of research has established the connection between functional health status and the chronic conditions associated with aging, including arthritis (Verbrugge, Lepkowski, and Konkol 1991), stroke (Jette et al. 1988), diabetes (Moritz et al. 1994), heart disease (Guccione et al. 1994), and depression (Lenze et al. 2001). Respondents were asked to report as to whether a doctor had ever told them they had various chronic conditions, including diabetes, cancer, chronic bronchitis, heart disease, stroke, arthritis, and asthma. A summary score indicates the number of chronic conditions ever diagnosed. The analysis also controls for a set of health-related risk factors. Wave I (1992) body mass index (BMI) is separated into underweight (BMI ≤ 18.5), overweight (25.0 ≥ BMI ≤ 29.9), and obese (BMI ≥ 30.0) categories. Two dummy variables indicate whether respondents are current or former smokers.

Demographic Controls

Finally, the analysis also controls for demographic characteristics that may influence the shape of health trajectories. Among these are race (1=black; 0=white), Hispanic ethnicity (1=Hispanic; 0=not), gender (1=male; 0=female), birth year, and marital status at wave I (1=married; 0=single/divorced/widowed). Descriptive statistics for variables used in the analysis are presented in table 1.

[Table 1 about here]

ANALYSIS

The analysis proceeds in two-steps. The first step estimates a series of unconditional latent growth curve models of functional limitations under various functional forms. This is mostly descriptive and designed to establish the mean initial level of limitation, mean rate of change, and the appropriate functional form for the sample as a whole. The other purpose is to test for non-zero variances in the intercept and slope components to determine if further investigation of covariates is in order. If there is not significant between-subject variability in the intercept or slopes, then there is no need to pursue conditional models. The second step estimates conditional models to examine the correlates of individual deviations from the mean trajectory.

Latent Growth Curves

Various analytic frameworks have been developed to study intra- and inter-individual change over time. An increasingly common strategy uses latent growth curve models. Latent growth curve models have a number of characteristics that make them ideal for the study of trajectories of change over time. First, they take mean structures as well as covariance structures into account, which allows for the modeling of both individual and group trajectories. Second, because it can accommodate multiple time points at once, it can model and test complex functional forms in the outcome.

Following Curran and Hussong (2002), a linear model of repeated measures of functional limitations (Y) for individual *i* at time *t* can be expressed as

$$Y_{it} = \eta_{\alpha i} + \lambda_t \eta_{\beta i} + \varepsilon_{it} \qquad (1)$$

where $\eta_{\alpha i}$ and $\eta_{\beta i}$ respectively represent the intercept and slope for individual *i*, $\lambda_t = [0, 2, 4, 6, 8]$, corresponds to factor loadings for T=5 time periods observed at 2-year intervals, and ε_{it} are the individual and time-specific random errors. Individual intercepts (slopes) can then be expressed as a function of the overall mean group intercept (slope) μ_α (μ_β) and their individual deviation from it $\zeta_{\alpha i}$ ($\zeta_{\beta i}$).

$$\eta_{\alpha i} = \mu_\alpha + \zeta_{\alpha i} \quad (2)$$
$$\eta_{\beta i} = \mu_\beta + \zeta_{\beta i} \quad (3)$$

The model can be extended to include nonlinear trajectories, such as a quadratic:

$$Y_{it} = \eta_{\alpha i} + \lambda_t \eta_{\beta 1i} + \lambda_t^2 \eta_{\beta 2i} + \varepsilon_{it} \quad (1a)$$
$$\eta_{\alpha i} = \mu_\alpha + \zeta_{\alpha i} \quad (2)$$
$$\eta_{\beta 1i} = \mu_{\beta 1} + \zeta_{\beta 1i} \quad (3)$$
$$\eta_{\beta 2i} = \mu_{\beta 2} + \zeta_{\beta 2i} \quad (4)$$

The functional form can also be left unspecified by estimating a two factor model in which $\lambda_t = [0, *, *, *, 1]$. In this model, $\eta_{\beta 1}$ represents a general shape factor of total change over the period rather than as an annual rate of change.

Finally, to estimate the predictors of variability in η_α or $\eta_{\beta 1}$ the model can be extended as:

$$\eta_{\alpha i} = \mu_\alpha + \mathbf{\Gamma X} + \zeta_{\alpha i} \quad (2a)$$
$$\eta_{\beta i} = \mu_\beta + \mathbf{\Gamma X} + \zeta_{\beta i} \quad (3a)$$

where the vector $\mathbf{\Gamma}$ represents the effects of $\mathbf{X}$, a vector of covariates, on the latent intercept and slope(s). The above model is estimated using covariance and mean structures, which assume a Gaussian distribution of the outcome. However, other research suggests that when the Gaussian assumption is not met, then estimated standard errors may be too small (Long 1997; Raudenbush and Bryk 2002). Alternative model specifications based on a Poisson and Zero-Inflated Poisson distribution (ZIP) yielded the same substantive results, suggesting that this analysis was not sensitive to this distributional assumption.

RESULTS

Observed Functional Health Trajectories

Over the 8 years of observation, the mean number of functional limitations increases by about one-third, from 1.91 per respondent in 1994 to 2.53 in 2002. At first glance, the shape of that change appears to be non-linear over the entire period. As seen in Figure 1, growth in functional limitations appears to be faster in last 4 years than over the first 4. The amount of sample variation in functional limitations also increased over the time period, suggesting that the disablement process is not uniform across individuals. Figure 2 highlights the variation in initial levels of specific functional limitations and in their trends. Nearly one-third of those sampled reported difficulty with activities associated with large lower body muscle groups such as climbing several flights of stairs, stooping and kneeling, and getting up from a chair after having sat for a while. However, only 4.1% had difficulty with fine motor activities such as picking up a dime from a table. While all activities saw an increase in the number of respondents having difficulty over the period, some, such as sitting for two hours, saw relatively modest increases (9.5%), while others, such as walking a block, experienced dramatic increases (248%). It is important to note that these patterns represent sample averages and are driven by both individual age-related increases in limitation over time and by mortality selection that disproportionately removes those with more limitations from the sample. These are therefore likely to be lower-bound estimates of the average trajectory.

[Figures 1-2 about here]

Unconditional Latent Growth Curves

Table 2 presents various model fit indices and curve parameters for unconditional models of functional limitation assuming different functional forms including freely-estimated, linear, and quadratic. The linear model does not fit the data particularly well (χ^2_{df} =464.89_{14}). Leaving the functional form unspecified results in a significant improvement in model fit. The Chi-square declines by 57.15 to 407.74 at the cost of 3 degrees of freedom. However, this model still does not provide the best fit to the data. Adding a latent quadratic term to the model improves the fit of the model substantially. The Chi-square declines by more than 75% from the linear model to 114.62. By all indicators, the quadratic model is a reasonably good fit to the data and is highly superior to the linear and the unspecified models. The mean of the quadratic term is statistically significant and positive. The variance in the intercept, linear, and quadratic terms are all statistically significant, indicating that there is substantial variability across individuals in the initial level of functional health status at wave 2 and different rates of change.

[Table 2 about here]

The Determinants of Functional Health Trajectories

Having found significant variation in the level and shape of functional health trajectories, table 3 presents estimates of the determinants of those trajectories based on nested quadratic models. Models 1-4 present estimates of the effect of childhood SES, childhood health, adult SES, and adult health on trajectories of functional limitations, respectively. Each of these models further includes controls for demographic background. Model 5 includes both childhood health and SES. Model 6 further adds adult SES. Finally, model 7 (full model) adds adult health.

Parameter estimates are interpreted as reflecting deviation from the average underlying trajectory described in table 2. Positive effects on the intercept increase the level at baseline, while negative ones reflect lower initial levels. For example, having a father that did not complete high school has a positive effect (0.32 in model 1) on the intercept, meaning that on average those with less educated fathers report 0.32 more functional limitations at outset than those whose fathers were high school graduates.

When each is examined separately in models 1-4, both early (health and SES) and later life (health and SES) circumstances are significantly associated with trajectories of functional limitations. Disadvantaged family background is associated with more initial limitations (model 1). This was true whether low childhood SES was indicated by having parents that did not complete high school, reporting poor overall family SES, having moved due to financial problems, or having an absent or unemployed father. Those whose father completed more than high school report smaller increases in limitations over time, as did those who did not experience economic shocks (father unemployed, family moved because of financial difficulties). However, there is some nonlinearity in these associations. Poor childhood SES is also associated with functional health trajectories. Those who report excellent childhood health had on average 1.5 fewer functional limitations in 1994 than those with poor childhood health (model 2). Better childhood health is also associated with less steep increases in limitations over time. There is a distinct economic gradient in functional limitations. Those with higher levels of education and household income and wealth also had substantially lower levels of functional limitations at baseline, though current SES does not appear to be associated with subsequent changes in limitations (model 3). There is also a very strong association between current health and functional status in 1994 (model 4). Each additional chronic condition is matched with approximately one additional limitation. Similarly, those that are overweight, obese, or current smokers were also more limited in 1994. As with SES, adult health does not appear to be associated with patterns of change in functional health status.

When both childhood health and family SES are included in the model (model 5), the estimated effects of each of these on trajectories of functional limitations are attenuated but remain statistically significant. Also, together they account for more variance (13%) than each does separately (10%). This suggests that while some of the adverse effect of poor childhood SES is acting via poor childhood health, each of these is also associated with functional limitations independent of the other. Interestingly, the change components of the trajectories barely change from model to model.

Adult socioeconomic attainment is included in model 6. The estimated effects of early life conditions on the latent intercept of functional limitations are again attenuated. This is especially the case for childhood SES, where the estimated associations are reduced by about half. This would suggest that diminished economic attainment (in part through health selection associated with poor childhood health) is an important mechanism by which adverse childhood conditions manifest themselves in regard to adult functional health status. However, there continues to be strong associations between childhood health and SES and functional limitations that are not accounted for by adult SES.

The full model (model 7) further adds controls for adult health status. The association between childhood SES and the latent intercept of functional limitation is substantially attenuated with the inclusion of adult health. Of the childhood SES measures, only the indicator of overall poor childhood SES continues to be statistically significant. The steeper increase in limitation associated with disadvantaged social background is virtually unchanged. As would be expected given the strong association between childhood health and adult chronic disease, the effect of childhood health is substantially reduced when adult health is included in the model. Interestingly, this association continues to be statistically significant with those who had poor childhood health, having 0.6 more initial limitations and steeper increases over time than their peers with excellent childhood health. Altogether, roughly half of the association between childhood health and initial functional limitation but none of its association with patterns of change are accounted for by adult health and SES. Again, adult health and SES continue to be an important predictor of baseline functional limitation but is not associated with change over time.

A final, yet puzzling finding is that while the model does fairly well in explaining between-subject differences in initial level of functional limitation, accounting for 40% of the variance in the latent intercept, the robust set of covariates investigated here do a rather poor job of explaining between-subject differences in patterns of change in limitations over time. They only account for 4% of the variance in the linear component of change and 5% in the nonlinear component of change.

[Table 3 about here]

DISCUSSION

Few studies have examined whether the social, physiologic, and economic circumstances of early life shape functional health trajectories at older ages. No previous studies have taken advantage of the longitudinal nature of the HRS by modeling trajectories of change in functional limitations over multiple time points. This study fills an empirical void by examining the extent to which early life circumstances influence the level and shape of functional health trajectories in the near-elderly. The results demonstrate that adult trajectories in functional limitation continue to be shaped by childhood health and socioeconomic circumstances. Poor health in childhood and disadvantaged social background are associated with both increased baseline limitation and steeper trajectories over time. These associations are net of adult chronic disease and socioeconomic status, though more proximate health and SES partially mediate childhood impacts on functional health status.

The results also complement and extend recent studies that have linked early life conditions to adult health and mortality. Lou and Waite (2005) Haas (2004) and Blackwell, Hayward, and Crimmins (2001) have previously shown poor childhood health to be associated with increased adult chronic diseases. The present study confirms that this increased risk of chronic disease results in increased functional limitation. Furthermore, while Blackwell et al. (2001) examined adult health at one point in time, and Haas (2004) looked at change over a 2-year interval, this study shifts the attention toward the dynamics of change in adult health over time by showing that childhood factors influence both the overall level and trajectories of adult health over time.

A limitation of this analysis is that while it represents a step forward by explicitly modeling change in functional health over time, it treats the covariates of that change as static effects when it estimates them. Though baseline values of the covariates do a fairly good job of explaining variance in the initial levels of disability in 1994, they are less able to explain the variability in change over time. There is ample reason to suspect that change in some of these factors may also affect the shape of trajectories. While the effect of childhood health and socioeconomic conditions obviously represent a temporally fixed effect, an increase in the number of chronic health conditions would likely lead to a substantial increase in the slope of functional health trajectories over time. Future analysis should expand the universe of covariates of interest and investigate the effect of time-varying covariates on the dynamics of functional limitation over time.

Another limitation is that it is difficult to tease apart the precise causal processes linking childhood health and adult functional limitation. This relationship may be causal in that childhood health insults permanently alter the structure and function of the body creating a constant debilitation over the life course or by generating latent effects that manifest themselves much later (Barker 1994). Conversely, this relationship may spuriously reflect common prior causes such as some underlying genetic factor that increases frailty or otherwise predisposes individuals to increased health risks both in childhood and in adulthood. In order to shed light on the underlying causal processes involved, it is necessary to have detailed information on the nature of childhood health conditions and data on siblings. Unfortunately, the HRS contains neither sufficient detail about childhood health nor sibling data that may allow for adjudication between these perspectives.

An additional issue of concern is that the influence of childhood health on adult functional status may be contingent on its interaction with socioeconomic status over the life course. There is constant interaction between health and socioeconomic status over the life course, and it is difficult to disentangle the causal processes involved. For example, childhood health is in part a function of childhood socioeconomic conditions, and subsequently has significant impacts on the status attainment process (Haas 2006).The above analysis further has shown that a substantial portion of the influence of poor childhood health and disadvantaged social background on the initial level of limitation (though not their influence on change in limitations) is mediated through adult socioeconomic attainment. This confirms previous research that has found that upward social mobility moderates the adverse impact of low childhood SES (Lou and Waite 2005). Thus, those who are able to achieve socioeconomic success despite childhood health insults and disadvantaged social origins may have substantially improved functional health trajectories than their peers who are not.

At the same time, while childhood economic status is predictive of both baseline functional limitation and changes over time, current household income and wealth are only associated with the initial level of limitation. One reason for this may be that the impact of economic status on health plays out over a longer period of time than that observed here. Smith (2005) has shown recently that the effect of income on chronic disease onset is relatively small in the short term. Conversely, baseline limitations are the result of cumulative insults to health over the entire life course prior to first observation, including those associated with economic disadvantage. It is not surprising, then, that the initial level of functional limitation is more sensitive to current economic standing than are short terms changes. Another possibility is that during the observation period a large and increasing portion of the sample is covered by Medicare, which may act to further minimize income and wealth (though not necessarily education) differences in functional health status by equalizing access to health and personal care and assistive technology.

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TABLE 1. DESCRIPTIVE STATISTICS HRS (1992-2002)

	%	Mean	SD
Functional Limiations			
Functional Limitations 1994		1.91	2.51
Functional Limitations 1996		2.02	2.63
Functional Limitations 1998		2.11	2.65
Functional Limitations 2000		2.27	2.77
Functional Limitations 2002		2.53	2.84
Childhood Health and SES			
Childhood Health		3.16	1.00
Mother Educ. Missing	8.9		
Mother Educ. <12 Years	55.0		
Mother Educ. >12 Years	9.9		
Father Educ. Missing	12.2		
Father Educ. <12 Years	55.4		
Father Educ. >12 Years	11.0		
Family SES Poor	31.8		
Family Moved Due to Financial Problems	17.6		
Father Ever Unemployed	19.5		
Father Absent	9.3		
Current SES			
Education (years)		12.16	3.22
Household Income (log)		10.48	3.22
Household Wealth (log)		10.73	3.26
Demographic			
Black	15.5		
Hispanic	9.4		
Male	44.1		
Birth Year		1936.93	5.45
Married	82.1		
Health Factors			
Current Smoker	25.0		
Former Smoker	35.9		
BMI ≤18.5	1.0		
BMI ≥ 25 ≤ 29.9	41.2		
BMI ≥ 30	23.4		
# Chronic Conditions		0.98	1.06
N		10,961	

TABLE 2. MODEL FIT INDICES AND CURVE PARAMETERS FOR UNCONDITIONAL LATENT GROWTH CURVES OF FUNCTIONAL LIMITATIONS UNDER VARIOUS FUNCTIONAL FORMS (HRS 1994-2002)

	Model Fit Indices				**Growth Curve Parameters**					
					Intercept		Linear Term[a]		Quadratic Term	
	X^2 (*df*)	BIC	CFI	RMSEA	Mean	Variance	Mean	Variance	Mean	Variance
Funtional Limitations										
Linear Model	464.89 (14)	331.67	0.99	0.06	1.87***	5.00***	0.07***	0.04***	–	–
Freely-Estimated Model	407.74 (11)	305.42	0.99	0.06	1.90***	5.00***	0.59***	2.27***	–	–
Quadratic Model	114.62 (10)	21.60	1.00	0.03	1.92***	4.83***	0.02**	0.14***	0.01***	0.00***

Notes

* $p< .05$; ** $p< .01$; *** $p< .001$

[a] for Freely estimated model this represents the total change over the period rather than a linear slope.

BIC= $X^2 - (ln(N) * df)$

All models assume constant error variances

TABLE 3. PARAMETER ESTIMATES FROM GROWTH CURVE OF FUNCTIONAL LIMITATIONS (HRS 1994-2002)

	Model 1			Model 2			Model 3			Model 4		
	Intercept	Linear	Quadratic	Intercept	Linear	Quadratic	Intercept	Linear	Quadratic	Intercept	Linear	Quadratic
Childhood SES												
Mother Education Missing	0.46***	0.06	-0.01									
Mother Education <12 Years	0.14*	0.03	-0.00									
Mother Education >12 Years	-0.14	0.01	-0.00									
Father Education Missing	0.47***	-0.07*	0.01**									
Father Education <12 Years	0.32***	-0.02	0.00									
Father Education >12 Years	-0.12	-0.07*	0.01*									
Family SES Poor	0.24***	-0.01	0.00									
Moved Due to Financial Probs.	0.23***	0.06**	-0.01**									
Father Ever Unemployed	0.15*	0.05*	-0.00									
Father Absent	0.23**	0.00	-0.00									
Childhood Health												
Childhood Health				-0.37***	-0.02*	0.00*						
Current SES												
Education (years)							-0.12***	0.00	-0.00**			
Household Income (log)							-0.25***	0.01	0.00			
Household Wealth (log)							-0.13***	0.00	-0.00			
Adult Health												
BMI ≤18.5										0.36	-0.02	-0.01
BMI ≥ 25 ≤ 29.9										0.27***	0.03	-0.00
BMI ≥ 30										0.80***	0.01	0.00
Current Smoker										0.53***	0.03	0.00
Former Smoker										0.04	-0.00	0.00
# Chronic Conditions										0.98***	0.01	-0.00
χ^2 (*df*)	137.64 (55)			117.75 (28)			137.89 (34)			132.84 (43)		
BIC	-373.97			-142.71			-178.38			-267.15		
R^2	.10	.03	.04	.10	.02	.03	.18	.02	.03	.34	.02	.03

* *p*< .05; ** *p*< .01; *** *p*< .001

TABLE 3. CONTINUED

	Model 5			Model 6			Model 7		
	Intercept	Linear	Quadratic	Intercept	Linear	Quadratic	Intercept	Linear	Quadratic
Childhood SES									
Mother Education Missing	0.39***	0.06	-0.01	0.08	0.07*	-0.01*	0.06	0.07	-0.01*
Mother Education <12 Years	0.13*	0.03	-0.00	-0.02	0.04	-0.00	-0.04	0.04	-0.00
Mother Education >12 Years	-0.16	0.01	-0.00	-0.03	0.00	0.00	0.02	0.00	0.00
Father Education Missing	0.45***	-0.08*	0.01**	0.20*	-0.06	0.01*	0.09	-0.06	0.01*
Father Education <12 Years	0.30***	-0.02	0.00	0.17**	-0.01	0.00	0.11	-0.01	0.00
Father Education >12 Years	-0.09	-0.07*	0.01*	0.08	-0.08*	0.01*	-0.10	-0.07*	0.01*
Family SES Poor	0.20***	-0.01	0.00	0.11*	-0.01	0.00	0.10***	-0.00	0.00
Moved Due to Financial Probs.	0.21**	0.06**	-0.01**	0.16*	0.06**	-0.01**	0.09	0.06**	-0.01**
Father Ever Unemployed	0.11	0.05*	-0.00	0.11	0.05*	-0.00	0.07	0.05*	-0.00
Father Absent	0.18*	-0.00	-0.00	0.11	0.00	-0.00	0.13	0.00	-0.00
Childhood Health									
Childhood Health	-0.33***	-0.02*	0.00*	-0.25***	-0.02*	0.00*	-0.15***	-0.02*	0.00*
Current SES									
Education (years)				-0.10***	-0.01**	-0.00***	-0.08***	-0.01**	-0.00**
Household Income (log)				-0.23***	0.01	0.00	-0.17***	0.01	-0.00
Household Wealth (log)				-0.12***	0.00	-0.00	-0.08***	0.00	-0.00
Adult Health									
BMI ≤18.5							0.28	-0.01	-0.01
BMI ≥ 25 ≤ 29.9							0.23***	0.03	-0.00
BMI ≥ 30							0.74***	0.02	0.00
Current Smoker							0.33***	0.04	-0.00
Former Smoker							0.04	-0.00	0.00
# Chronic Conditions							0.87***	0.00	-0.00
χ^2 (*df*)	140.90 (58)			165.41 (67)			184.99 (85)		
BIC	-398.62			-457.82			-605.68		
R^2	.13	.03	.04	.20	.04	.05	.40	.04	.05

** p< .05; ** p< .01; *** p< .001*

Figure 1. Trend in Functional Limitations HRS 1994-2002

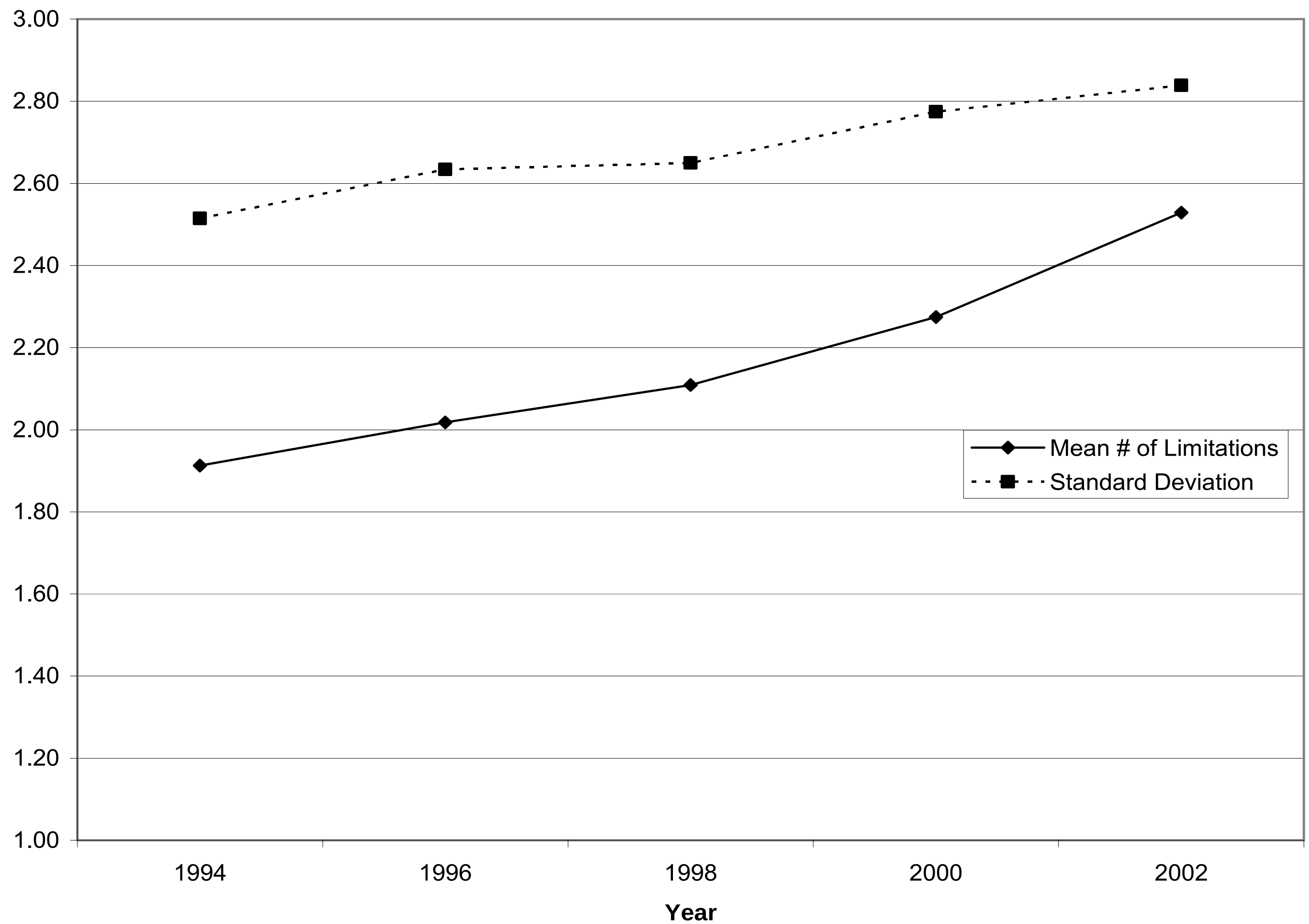

Figure 2. Trends In Specific Functional Limitations HRS 1994-2002