# Dynamic and Dyadic Relationships:
# An Extension of the Socioeconomic Status-Health Relationship

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ABSTRACT

The prevalence of childhood chronic conditions and activity limitations has substantially increased over the last several decades, shifting the focus from survival to improving the quality of life of children and their families. This paper investigates the interrelationship of child health and maternal health and socioeconomic factors over time, focusing on the dynamic nature of maternal and child health and socioeconomic outcomes during childhood. Using a series of latent growth curve models, this paper examines the association between trajectories of child activity limitations and maternal health, labor force participation and household poverty status in order to determine whether the association between child activity limitations and maternal health and socioeconomic outcomes is short-lived or long-lasting. There is evidence that child activity limitations and maternal health limitations have a positive contemporaneous association but do not have long-lasting effects on one another. However, maternal labor force participation at one point in time does appear to have a small positive effect on the trajectory of child activity limitations. Policy implications and plans for future research are discussed.

## THEORETICAL FRAMEWORK

### *Child health and maternal health and socioeconomic factors*

The positive association between higher levels of individual socioeconomic status and better health at various stages of the life course is well-documented and one of the most robust findings in sociological, demographic, and medical research (Adler et al. 1994; Kitagawa and Hauser 1973; Link and Phelan 1995). Empirical evidence from longitudinal data suggests that socioeconomic status drives much of the observed differences in health (Chandola et al. 2003; House and Williams 2000), but there is evidence that the direction of causality also flows from health to various markers of socioeconomic status (Garbarski 2010; Haas 2006; Palloni 2006; Smith 1999), such that the relationship between individual socioeconomic status and health is complex and interdependent over the life course.

Life course scholars and systems theorists highlight the embeddedness of individuals within institutions, social ties, and time (Bronfenbrenner 1977; Diez Roux 2007; Elder and Giele 2009). In these complementary frameworks, the notion that individual lives are linked lives means that one's health and socioeconomic events are potentially formative events in the lives of their family members (Elder 1985; Moen and Hernandez 2009). For example, research on the socioeconomic origins of adult health and mortality points to a range of prenatal and childhood conditions and experiences, shaped by parental health and socioeconomic status, that have far-reaching consequences for a child's health and socioeconomic status in their adulthood. Adverse childhood environments such as exposure to toxins, diseases, and malnutrition in utero and in childhood are linked to adult morbidity and mortality through physiological "scarring" (Barker 1998; Elo and Preston 1992; Marmot et al. 1984) and through adult health behaviors and socioeconomic outcomes which are then associated with adult health outcomes (Conley and Bennett 2000; Hayward and Gorman 2004; Palloni 2006; Palloni and Milesi 2006; Preston et al. 1998).

However, the intergenerational association between parental and child socioeconomic and health may flow in the other direction, where a child in poor health is a possible stressor that may directly influence the health and mental health of family members as well as increase socioeconomic

burdens for families. Parents of children in poor health or with activity limitations experience greater care burden compared to parents of children with no health limitations: they are responsible for more of the physical care of their children, helping children cope physically and emotionally with their condition, negotiating medical, educational, recreational, and other services, and experiencing concerns about their child's well-being and future prospects (Raina et al. 2004). Poor child health increases tension for and demands on parents, who may occupy additional social roles as spouses and employees, thus leading to symptoms of psychological and physiological distress (Breslau et al. 1982; Pearlin and Schooler 1978; Waddington and Busch-Rossnagel 1992).

In particular, the effect of child health on parental health and mental health outcomes can be explained in terms of a stress process perspective, where the stressors associated with having a child in poor health are conceptualized as chronic strains which produce psychological and physiological distress (Pearlin 1989; Pearlin et al. 2005). When an individual perceives a chronic environmental challenge – such as having a child in poor health – as stressful, these challenges lead to adverse physiological and psychological outcomes through chronic exposure to fluctuating or heightened neural, neuroendocrine, and immune system responses (Adler et al. 1994; McEwan and Seeman 1999; Taylor and Seeman 1999). Studies by Kiecolt-Glaser and colleagues (1996, 2003) and Miller and colleagues (2002, 2008) show that caregivers of family members with health conditions exhibit biomarker measures associated with reduced immune system functioning and increased inflammation compared to matched control subjects. Although conducted on small samples, these studies document a potential biologic pathway through which long-term stressor exposure contributes to the development and progression of poor health outcomes.

Clinical and population-based studies have demonstrated a risk for adverse health and mental health outcomes for mothers of children with activity limitations, developmental disabilities, and chronic health conditions, as well as a higher risk for adverse health and mental health outcomes compared to mothers of healthier children (Abbeduto et al. 2004; Early et al. 2002; Kuhlthau et al. 2010; Miller et al. 2002; Raina et al. 2005; Seltzer et al. 2001; Singer 2006; Witt et al. 2009; Witt et

al. 2010).[1] Having a child with activity limitations has also been shown to reduce the hours parents work, increase the number of workdays missed, and increase the risk of being unemployed or out of the labor force compared to parents of children with no limitations (Kuhlthau and Perrin 2001; Kuhlthau et al. 2010; Porterfield 2002; Powers 2001, Witt et al. 2009); however, the higher monetary costs reported for families with disabled children renders the decision to work less clear (Lukemeyer et al. 2000).

Researchers have begun to move away from the "categorical" or "disease-specific" approach to defining child health based on evidence of commonalities across childhood illnesses in terms of child functional status and the experiences of the children's families (Kohen et al. 2007; Stein et al. 1993). This paper defines child health status in terms of child activity limitation status. Defining child health using survey questions about activity limitations captures how children are physically, emotionally, or cognitively limited in a way that affects their age-appropriate activities, and improves upon the disease-specific approach because a diagnosis from a medical professional is not necessary, so that measures of child health are not limited to those who have medical care. A recent study estimates that 15.6% of children in the US have a reported activity limitation (Witt et al. 2009).

While studies have established associations among child activity limitations, maternal health and maternal socioeconomic factors at various stages of the life course either cross-sectionally or within a short follow-up period, it is unclear whether the effect of child health on maternal outcomes is short-lived or long-lasting, reflecting the potential for child health to have lasting effects on maternal health and socioeconomic trajectories. Similarly, maternal health and socioeconomic factors may have long-lasting effects on child health trajectories. Childhood and adolescence is a critical stage in the life course, but this period lasts for several years and may consist of several changes in health and socioeconomic factors for both mother and child. This paper attends to how the relationship between child health and maternal health and socioeconomic factors operates

[1] The majority of prior studies look at maternal outcomes, although some do examine paternal outcomes. The reasons are both theoretical and practical, in that mothers, most often the primary caregivers of children, are thus more likely to be affected by poor child health as well as be the parent interviewed in parent-child data collections.

dynamically by investigating how trajectories, or intraindividual patterns of stability and change, of child health are associated with trajectories maternal health and socioeconomic factors.

## DYNAMIC MODELS OF CHILD HEALTH AND MATERNAL HEALTH AND SOCIOECONOMIC FACTORS

Elder (1985) defines the life course as interlocking trajectories or pathways defined by sequences of events and transitions. This conceptualization suggests the possibility that trajectories of child health may impact maternal health and socioeconomic trajectories as well as the reverse. A short-term relationship between child health and maternal health and socioeconomic factors is expected in that the starting point or intercept of each trajectory will be associated, as prior research demonstrates that child health is associated with contemporaneous measures of maternal health and socioeconomic outcomes. Furthermore, there may be an association between child health and maternal health and socioeconomic trajectories over time because, particularly at this stage of the life course for both mother and child, health and socioeconomic factors and changes therein occur proximately and contemporaneously. This would be consistent with a short-term association between child health and maternal outcomes because the proximate changes in one trajectory would be reflected in the other.

*Hypothesis 1:* Consistent with prior research, child health will be associated with contemporaneous measures of maternal health and socioeconomic outcomes. More specifically, initial or intercept measures of child activity limitations and each maternal outcome will be associated.

*Hypothesis 2:* Trajectories of child health will be associated with trajectories of maternal health and socioeconomic outcomes. That is, changes in child activity limitations over time will be associated with changes in the maternal outcomes.

The association between child health and maternal health and socioeconomic factors may also be long-lasting, in that child health captured at one point in time may be associated with changes in the trajectories of the maternal outcomes and vice versa. The mechanism through which long-lasting effects are exerted on child and maternal health may be explained as stress proliferation, the process by which an initial stressor engenders a) the expansion of the initial stressor, b) additional stressors in

other life domains, c) additional stressors across the life course, and d) additional stressors across generations (Benson and Karlof 2009; Pearlin et al. 1997, Pearlin et al. 2005; Thoits 2010). For example, it is possible that initial child activity limitations influence future maternal health trajectories regardless of the child health trajectory that follows, because the effect of child health on maternal health occurs in part through other intervening mechanisms that are hard to observe or require a long duration of time after exposure to impact maternal health, such as markers of physiological responses to stress found in previous research (Kiecolt-Glaser et al. 1996, 2003; Miller et al. 2002, 2008).

Long-lasting effects of child activity limitations on maternal socioeconomic outcomes and long-lasting effects of maternal socioeconomic outcomes on child activity limitations would be consistent with path-dependent cumulative advantage, where a prior state conditions later (dis)advantages in the outcome of interest through a growing rate of return over the life course (Dannefer 1987; DiPrete and Eirich 2006; O'Rand 1996). The stratification research on cumulative advantage in the relationship between socioeconomic status and health posits that early socioeconomic and health advantages are translated into greater accumulation of human capital, psychosocial resources, positive lifestyle events, and subsequent socioeconomic advantages, which serve to increase the heterogeneity in health and socioeconomic outcomes over time. Among individuals, researchers have found increasing health returns with age or time given earlier socioeconomic advantage (House et al. 1994; Lynch 2003; Ross and Wu 1996; Willson et al. 2007), and increasing differentiation in adult labor market outcomes given childhood health status (Haas et al. 2011). Given the bounded nature of child health and maternal socioeconomic status at this point in the life course, it is easy to extend the path-dependent cumulative advantage hypothesis to expect long-lasting effects of child activity limitations on maternal socioeconomic outcomes and vice versa.

*Hypothesis 3:* Initial measures of child activity limitations will be associated with changes over time in maternal health and socioeconomic outcomes, and initial measures of each maternal health and socioeconomic factor will be associated with changes in child activity limitations over time.

However, there may be convergence in child health and maternal health and socioeconomic trajectories over time. For example, experiencing the stress of having a child with activity limitations may lead to maternal health and socioeconomic differences at a cross-sectional level or within a short follow-up period, but the effect may diminish with time as mothers adjust to the burdens and manage the stress of having a child with limitations. In contrast to Hypothesis 3, then, it is plausible that there is a convergence in maternal trajectories over time given exposure to child activity limitations, or convergence in child health trajectories given exposure to the various maternal health and socioeconomic factors.

Figure 1 schematizes the hypothetical ways in which child activity limitations may be associated with maternal health and socioeconomic factors. For ease, the figure includes only linear slopes and is not an exhaustive list of all the over-time relationships possible. Figure 1 represents repeated measures that increase over time. Using maternal health as an example, Path 1 in Figure 1a shows the trajectory of health limitations for mothers of children with no activity limitations at time 1; maternal health limitations are expected to increase over time as part of the aging process. Paths 2, 3, and 4 all start with a positive intercept shift, where, for example, child activity limitations at time 1 are positively associated with maternal health limitations at time 1, consistent with Hypothesis 1.

Path 2 in Figure 1a shows a positive intercept shift, but trajectories of maternal health converge over time, consistent with the converse of Hypothesis 3 (i.e., there is a positive association between the intercepts of maternal health limitations and child activity limitations, but there is no association between initial child activity limitations and the trajectory of maternal health limitations). Path 3 shows a positive intercept shift and a positive slope shift, where the trajectory of health for mothers of children with activity limitations at time 1 continues to worsen over time compared to the health trajectory of mothers of children with no limitations at time 1, consistent with Hypothesis 3 (i.e., there is a positive association between initial child activity limitations and the trajectory of maternal health limitations). Path 3 can also be interpreted as consistent with Hypothesis 2 if the slope of the child health trajectory is considered instead of the intercept (i.e., there is a positive association between the slopes of the child activity limitation and maternal health limitation

trajectories). Path 4 shows an intercept shift and a negative slope shift, such that mothers of children with activity limitations at time 1 show improvement in their health over time compared to mothers of children with no limitations at time 1 (i.e., initial child activity limitations are associated with a decline in the trajectory of maternal health limitations). (Figure 1b shows the same over time relationships but depicts a negative association between intercepts, e.g., the negative association between maternal labor force participation and child activity limitations expected based on prior research.)

## METHODS

### *Data*

Data come from the National Longitudinal Study of Youth 1979 (NLSY), a nationally representative sample of 12,686 men and women who were between the ages of 14 and 22 when first surveyed in 1979 (http://www.bls.gov/nls/nlsy79.htm). Data were collected yearly from 1979 to 1994, and biennially from 1996 to the present (the most recent wave of data available is 2008), initially to chronicle the labor force experience of this cohort. However, other sets of questions have been added over the years and broadened the scope of the survey. Starting in 1986, data on the children of NLSY 1979 female respondents were collected biennially from both the mothers and children (http://www.bls.gov/nls/nlsy79ch.htm).

The sample was restricted to mothers from the NLSY 1979 original cohort and their children. Because the analytic intent is to specify trajectories of child health and maternal outcomes across the childhood of the focal child, the sample was first restricted to children for whom data were collected during the course of their childhood through age 18, or children born between 1984 and 1991. There are 11,495 children of the NLSY 1979 women, and 41% of these children (4,694) were born in these cohorts. The data were pooled across time so that time 1 corresponded to children age 1 through 2 (because the data were collected biennially), time 2 to children age 3 through 4, and so on.[2] Thus,

[2] Control variables come from wave before the child is born in order to be able to adequately control for characteristics occurring prior to (and thus not affected by) the birth of the focal child. Time 0=controls; time 1=ages 1 and 2; time 2=ages 3 and 4; time 3=ages 5 and 6; time 4=ages 7 and 8; time 5=ages 9 and 10; time 6=ages 11 and 12; time 7=ages 13 and 14; time 8=ages 15 and 16; time 9=ages 17 and 18.

time 1 was 1986 for children born in 1984 and 1985, 1988 for children born in 1986 and 1987, 1990 for children born in 1988 and 1989, and 1992 for children born in 1990 and 1991; time 2 was 1988 for children born in 1984 and 1985, and so on. The sample was then restricted to mother-child pairs where information on the child's activity limitation status – the measure of child health used in this analysis – was reported during at least 6 of the 9 waves where the child is between the ages of 1 and 18 (42% of the children born between 1984 and 1991 had data on their activity limitations in all 9 waves of interest, and another 18% were missing data in just one, two or three waves, restricting the sample to 3,348 children). One child was then randomly selected for analysis because mothers reported on more than one child during the study, yielding a final sample of 2,225 mother-child pairs of data for analysis.

*Measures*

*Child activity limitation status*. Mothers of children under age 15 reported on whether the child currently had a condition that affected regular school attendance, regular school work, and usual childhood physical activities; and whether the child had a condition that required frequent attention or treatment from a health professional, the use of medicine or drugs, or the use of any special equipment. Children aged 15 and over reported on whether they currently had a condition that limited their ability to attend school regularly or do regular schoolwork; whether they had a condition that required frequent attention or treatment from a health professional, the use of medicine or drugs, or the use of any special equipment; and whether they were or would be limited in the kind or amount of work they could do for pay because of their health. If any one of these items had a "yes" response in a particular wave of data, the child was coded as having an activity limitation for that wave of data. If all items had a "no" response in that wave of data, the child was coded as having no limitation.

*Maternal health dependent variable.* Maternal health was defined as *maternal limitations in work due to health*, the only health measure consistently collected from 1979 through 2008. Measures of health-induced work limitations are highly correlated with self-reported health and produce comparable findings as measures of self-reported health when used as a dependent variable in multivariable analysis (Bound 1991). Measures of health-induced work limitations are also highly

correlated with disability, although the measure tends to understate the prevalence of disability in the working-age population (Burkhauser et al. 2002).[3] Mothers were coded as having a health limitation if they answered "yes" to any of the following questions: "[Are you/Would you be] limited in the kind of work you [could] do on a job for pay because of your health?"; "[Are you/Would you be] limited in the amounts of work you [could] do because of your health?"; (for those not working for pay) "Would your health keep you from working on a job for pay now?" Respondents reporting "no" to all three questions were coded as not having a health limitation.

*Maternal socioeconomic dependent variables.* The measure of employment status used in this analysis was *maternal labor force participation,* defined as no time spent unemployed and unavailable for work at least one week in the last year. "Unavailable" means that the person was not looking for work, for example because they were engaged in housework, in school, unable to work because of long-term physical or mental illness, retired, or voluntarily idle. *Family poverty status* was defined as the total family income being below the poverty level for the last year, as issued by the U.S. Department of Health and Human Services and based on Census Bureau poverty guidelines.

*Sociodemographic control variables.* Sociodemographic control variables were included in the models in order to reduce spurious relationships. Where possible, the values for the sociodemographic control variables were measured one wave before the child was born in order to minimize control-away bias (see, e.g., Kim 2011). Control-away bias occurs when the effects of the explanatory variable on the outcome are estimated using control variables from a point in time when those control variables may be endogenously associated with the explanatory and response variables, leading to analyses that underestimate the total effect of the explanatory variable on the outcome. The maternal control variables measured one wave before the focal child was born include maternal race, ethnicity, age, highest grade completed, body-mass index (BMI), marital status, poverty status, any time unemployed, any time out of the labor force, a health-induced work limitation, and the number of children in the household. Maternal smoking was measured in 1984 for all mothers.

[3] The measure of maternal limitations in work due to health was correlated with the following health and mental health measures obtained when women in the NLSY 1979 sample turned 40: self-reported health, .42; SF-12 physical, .68; SF-12 mental, .25; CES-D, .31.

Information on the child's sex, birth weight, whether the child was breastfed, and child health insurance coverage at time 1 were included in the model as time-invariant control variables. Birth weight is a useful heuristic for examining the relationship between socioeconomic status and health and mortality. Because a child has little control over the condition in which it is born, birth weight can be viewed as a broad indicator of familial socioeconomic and health context (Conley and Bennett 2000). Similarly, initiation and length of breastfeeding can also be seen as a proxy for other health-protective and IQ-promoting behaviors for children that go unmeasured in observational studies (Artis 2009). These variables are potentially powerful control variables when dealing with observational data on health, as they help to control for features of familial socioeconomic and health context not captured elsewhere.

*Analytic strategy*

Table 1 presents the descriptive statistics for the analytic sample, weighted to adjust for the multiple survey years from which the data were drawn as well as the oversampling of certain populations in the NLSY 1979. The table compares the means and proportions of the covariates of interest across child activity limitation status at time 1 (any vs. no limitation). Mothers of children with activity limitations at time 1 are less likely to be Hispanic, married, spend any time out of the labor force, and more likely to be unemployed and have a health limitation at baseline compared to mothers of children with no limitations at time 1. Mothers of children with activity limitations at time 1 are less likely to be normal weight and more likely to be obese at baseline than mothers of children with no limitations. Children with activity limitations are more likely to be male, low birth weight, and covered by insurance than children with no limitations at time 1.

Latent growth curve models were used to examine hypotheses centered on interindividual differences in intraindividual changes over time. Growth curve models nest repeated measures of events (level 1) within individuals (level 2) over time, producing average trajectories of events and permitting covariate estimates of these trajectories. Figure 2 (adapted from Bollen and Curran [2006]) illustrates an example of the measurement model of a bivariate latent growth curve model, which simultaneously fits the latent curve structure to two repeated measures and relate the parameters of

each curve with the other in order to describe the interrelationship between the two trajectories across the period (Meredith and Tisak 1990, Bollen and Curran 2006).[4] More specifically, the two repeated measures are related to each other solely at the level of the latent curve factors such that the intercepts and slopes of each growth curve may be correlated with one another. In this sense, a bivariate latent curve model of child activity limitations and maternal health, for example, simultaneously accounts for the trajectories of each process and their interplay over time in order to investigate how maternal health histories respond to histories of child activity limitations and vice versa. Importantly, because time-invariant covariates are introduced into the model as control variables, the association between the growth factors is estimated at the level of the residual or disturbance of the growth factors. A significant covariance in the disturbances indicates an association in the unexplained variance of each growth parameter. (Appendix A, available from the author, contains information on latent growth curve model estimation for this analysis.)

An interrelationship between initial measures of child activity limitations and each maternal factor of interest is the first hypothesis examined. In a bivariate latent curve model, a correlation between the intercepts of the child activity limitations and maternal health trajectories is expected, demonstrating an association between the two repeated measures at the same (initial) point in time. Hypothesis 2 posits that trajectories of child activity limitations are associated with the trajectories of each maternal outcome. In the bivariate latent curve model, this is demonstrated by a covariance between the slopes of the trajectories. Hypothesis 3 posits that the initial measure of child activity limitations is associated with trajectories of each maternal health and socioeconomic factor, and that initial measures of each maternal factor are associated with the child activity limitations trajectory. In the bivariate latent curve model, this is demonstrated by a covariance between the intercept of one repeated measure and the slope of the other repeated measure, e.g., the intercept of child activity limitations and the slope of maternal health growth curve.

[4] The models can also be extended to look at more than two sets of repeated measures, and are then referred to as multivariate latent curve models (Bollen and Curran 2006).

## RESULTS

### *Univariate latent curve models*

Univariate latent curve models of increasing functional forms were examined using model fit statistics to determine the best-fitting functional form for each repeated measure (Table 2). The best-fitting model for child activity limitations has a positive linear slope factor and a negative quadratic slope factor, indicating that, on average, there is a positive linear increase in the probability of activity limitations and that the curve increases less steeply with age (Table 3).[5] Furthermore, the best-fitting model for child activity limitations shows significant inter-individual variability in the intercept and linear slope growth factors, but no random effects for the quadratic growth factor. The results for the repeated measure of maternal health status are similar to that for child activity limitations. Maternal labor force participation (no time unemployed and not looking for work) follows a positive linear growth curve over the childhood of the focal child. In other words, the probability of being in the labor force increases linearly as the child grows older. The mean of the slope growth factor for household poverty status is negative but not significant, indicating that there is no significant change in household poverty status over time, although there is significant inter-individual variability in the rates of change, evidenced by a significant variance for the slope growth factor of household poverty (Table 3).

### *Conditional bivariate latent curve models*

*Maternal health.* The over-time relationship between maternal health and child activity limitations was examined in a bivariate growth curve model where the disturbances of the growth parameters were allowed to covary (see Figure 2). This model was a good fit to the data ($X^2(322) = 453.724$, $p<0.001$, RMSEA = 0.014, CFI =0.987, TLI =0.982).[6,7] There was a significant positive

[5] As discussed in Appendix A, the mean of the intercept growth factor is fixed to 0 in order to identify a growth curve model with dichotomous repeated measures.

[6] While the chi-square is significant, indicating that the model is not a good fit to the data, this is partially due to greater statistical power from using a large sample, and partially due to the inclusion of several control variables that do not have individual significant effects on the growth parameters but are included in the model because, taken together, they have substantive implications for the estimation of the growth parameters. Thus, the evaluation of model fit will consider goodness of fit statistics in addition to the chi-square. A root mean square error of approximation (RMSEA) of less than 0.05 is considered a good fit, while values of less than 0.08 are considered marginally good fit (Kline 2005). The

covariance between the disturbances of the intercept growth factors of the child activity limitations and maternal health trajectories, indicating that the initial values for child activity limitations and maternal health limitations were positively associated (Table 4). This is consistent with Hypothesis 1 as well as prior research demonstrating the association between contemporaneous measures of child activity limitations and maternal health.

The covariance in the disturbances of the slopes of the maternal health and child activity limitation growth curves was not significant, indicating that the slope of the maternal health trajectory did not vary as a function of the slope of the child health trajectory and vice versa. Thus, contrary to the Hypothesis 2, changes over time in child activity limitations were not associated with changes in maternal health.[8] In contrast to Hypothesis 3, there was no association between initial child activity limitation status and the slope of the maternal health trajectory, and no association between initial maternal health and the slope of the child activity limitation trajectory. These findings are consistent with Path 2 in Figure 1a: there is a difference in maternal health status at time 1 associated with child health status, but this difference diminishes over time; conversely, there is a difference in child health status at time 1 associated with maternal health status, but this difference diminishes over time. The associative nature of these models is emphasized; since the repeated measures and trajectories derived from them occur at the same points in time, it is problematic to make any causal inference from these associations.

*Maternal labor force status.* The over-time relationship between maternal labor force participation and child activity limitations was examined in a bivariate latent growth curve model where the disturbances of the growth parameters were allowed to covary. This model was a good fit to the data ($X^2(339) = 550.909$, $p<0.001$, RMSEA = 0.017, CFI =0.978, TLI =0.972). In support of

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comparative fit index (CFI) and the Tucker-Lewis index (TLI) each compare the fit of the baseline model (the model with no relationships specified among variables) and the estimated model (they differ in how they account for degrees of freedom), where values less than .90 suggesting poor fit and values greater than 1 (for the TLI; the CFI is capped at 1) possibly suggest overfitting the model (Bollen and Curran 2006).

[7] Oftentimes the model is specified so that there is a covariance between the time-specific disturbances of each repeated measure to capture any remaining association between the repeated measures. Because the analysis used the Delta parameterization (see Appendix A), the covariance is between the time-specific scale factors.

[8] The quadratic slope factors have disturbances equal to zero per model specifications discussed above, and thus these factors do not covary with the other growth factors.

Hypothesis 1, there was a significant negative covariance between the disturbances of the intercept growth factors of the child activity limitation and maternal labor force participation growth curves (Table 4). This is consistent with prior research showing that having a child with activity limitations is negatively associated with concurrent maternal labor force participation.

Contrary to Hypothesis 2, the covariance in the disturbances of the growth slopes of maternal labor force participation and child activity limitations was not significant, indicating that the slope of the maternal labor force participation trajectory did not vary as a function of the slope of the child activity limitation trajectory (Table 4). For maternal labor force participation, the findings are consistent with Path 2 in Figure 1b: maternal labor force participation at time 1 is negatively associated with concurrent child activity limitation status, but the difference in maternal labor force participation diminishes over time. However, maternal labor force participation at time 1 was associated with the slope of the child activity limitation growth curve, consistent with Path 3 in Figure 1b (Table 4). Thus, there is partial support for Hypothesis 3, in that maternal labor force participation at time 1 was associated with the slope of the child activity limitations trajectory, which increases over time.

*Household poverty status.* The bivariate latent curve model of child activity limitations and household poverty status was a good fit to the data ($X^2(339) = 423.912$, $p<0.001$, RMSEA = 0.011, CFI =0.987 , TLI =0.984). There were no significant cross-domain disturbance covariances for the intercept and slope growth factors (Table 4). Contrary to the hypothesized relationships, there was no difference in the initial level or rate of change of household poverty status based on child activity limitation status, and there was no difference in the initial level or rate of change of child activity limitation status based on household poverty status.

*Attrition from panel surveys.* Continued survey participation is intimately related to the variables of interest in this study. Data loss in longitudinal panels due to death and attrition winnows the sample so that those who remain are increasingly the healthiest and wealthiest people, leading to underestimated inequalities in health and socioeconomic status over time. With little exception, the results reported above remain the same when an adjustment was made to account for the propensity

to be included in the analytic sample. (Appendix B, available from the author, contains information on this estimation strategy.)

## DISCUSSION

The dynamic relationship between child health and maternal health and socioeconomic factors has theoretical and practical implications. Theoretically, the over-time relationship between child health and maternal factors such as health and socioeconomic status has not been adequately explored, creating a nexus among diverse literatures in epidemiology, social relationships, stress processes, life course research, and research on social stratification. The notion that one's health and socioeconomic events are potentially formative events in the lives of their family members means that policy efforts to reduce adverse health outcomes for individuals may have additional health and socioeconomic benefits for others in their social network. However, if differences in maternal health and socioeconomic factors due to child health status and vice versa are short-term or long-term but not both, such patterns dictate different societal interventions.

In contrast to Hypothesis 3, initial child activity limitation status was not associated with changes in maternal health over time, and initial maternal health status was not associated with changes in child activity limitation status over time. Thus, child health and maternal health are associated at one point in time, but trajectories of maternal health converge over time with respect to initial child health status, and trajectories of child health converge over time with respect to initial maternal health status. From a policy standpoint, this does not imply that there should be no interventions to ameliorate the effects of child health on maternal health and vice versa. Rather, it implies policies that target the health of the family at the time of the child activity limitation or maternal health limitation so that even the short-term effects on child and maternal health are not experienced. These short-term effects represent costs to insurance companies and the economy, as a healthy workforce is a more productive workforce. Furthermore, stratification research shows that poor health in childhood has long-term implications for the adult health and socioeconomic prospects of the child (Conley and Bennett 2000; Haas 2006; Haas et al. 2011; Palloni 2006).

The results from the models including child activity limitations and maternal labor force participation tell a different story, namely that maternal labor force participation at time 1 is associated with increasing child activity limitations over time, although there is a negative association between maternal labor force participation and child activity limitations at time 1. It is important to note that while this coefficient is quite small, it represents an effect of maternal labor force participation on child activity limitations that is multiplied with time as part of the growth curve model (see also Willson et al. 2007). Consistent with a path-dependent cumulative advantage mechanism, the impact of initial maternal labor force participation accumulates through a growing rate of return to child activity limitations (see, e.g., DiPrete and Eirich 2006). It is plausible that maternal labor force participation at time 1 is a proxy for lower socioeconomic status that is not quite captured by poverty status and is associated with poorer health outcomes for children over time. Future analyses will examine how maternal job quality as well as marital status and spousal characteristics may yield a more refined picture of the association between child health and maternal labor force participation in particular and socioeconomic status overall.

The findings from this study indicate that mothers of children with activity limitations at time 1 have the same trajectory of poverty status as mothers of children with no limitations. This may be a welcome surprise, meaning that families in poverty, who already contend with so much, do not bear the brunt of child activity limitations more so than their socioeconomically-advantaged counterparts. But it is also unfortunate in that one of the key ways to identify at-risk populations did not predict initial levels or rates of change in activity limitation status. This finding may be preliminary evidence that child activity limitations are a rather exogenous shock to the family system.

The results reported here may vary depending on maternal race and ethnicity, and this possibility will be investigated in future analyses. Future analyses will also investigate whether different initial starting points in the trajectories change the results reported here, and whether time-specific or state-like associations among the repeated measures play a role in the relationship between child health and maternal health and socioeconomic outcomes beyond the associations among the growth parameters. Furthermore, this study used longitudinal data to control for baseline measures of

covariates that could lead to a spurious relationship between child activity limitations and maternal health and socioeconomic outcomes, but the results may be biased to the extent that these controls were not exhaustive or were imperfect measures of the constructs they proxy. The extent to which this is the case will be examined in the future using an estimation procedure for an autoregressive cross-lagged model with fixed effects in a structural equation modeling framework put forth by Bollen and Brand (2010) to control for unmeasured stable covariates.

The relationship between child activity limitation status and maternal health and socioeconomic outcomes may also be overestimated to the extent that the maternal reports exhibit response bias, such as a tendency to report positively or negatively to survey questions. This supposition will also be examined in the future, using analyses that account for child-reported activity limitation status. Finally, it should be noted that child activity limitations is a broad measure of child health status. It is plausible that more refined measures of child health that contain information on the severity of conditions or limitations may yield different results from those reported here, conditional on enough observations for sufficient statistical power.

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Table 1. Descriptive Statistics of Covariates by Child Activity Limitation Status at Time 1, N=2,225

| | No Child Activity Limitation at T1 | | Any Child Activity Limitation at T1[a] | | |
|---|---|---|---|---|---|
| | Mean or Proportion | | Mean or Proportion | | Difference |
| Maternal age at birth of child | 27.00 | (0.04) | 26.99 | (0.10) | |
| Black [vs. not] | 0.15 | | 0.17 | | † |
| Hispanic [vs. not] | 0.08 | | 0.06 | | *** |
| Mother ever smoked [vs. not] | 0.80 | | 0.81 | | |
| Married [vs. not] | 0.63 | | 0.58 | | ** |
| Maternal health limitation [vs. none] | 0.05 | | 0.11 | | *** |
| Maternal labor force participation [vs. not] | 0.54 | | 0.45 | | *** |
| Household poverty status | 0.16 | | 0.16 | | |
| Any time unemployed [vs. not] | 0.24 | | 0.27 | | * |
| Number of children in the household | 0.81 | (0.01) | 0.72 | (0.03) | ** |
| BMI | | | | | |
| Normal weight | 0.75 | | 0.70 | | ** |
| Overweight | 0.18 | | 0.18 | | |
| Obese I | 0.05 | | 0.07 | | * |
| Obese II/III | 0.02 | | 0.05 | | *** |
| Highest grade completed | | | | | |
| Less than high school | 0.12 | | 0.11 | | |
| High school | 0.48 | | 0.50 | | |
| Less than four years of college | 0.23 | | 0.22 | | |
| Four or more years of college | 0.17 | | 0.17 | | |
| Female child [vs. male] | 0.49 | | 0.45 | | * |
| Child born low birth weight [vs. not] | 0.07 | | 0.10 | | ** |
| Child ever breastfed [vs. not] | 0.55 | | 0.55 | | |
| Child has health insurance [vs. not] | 0.88 | | 0.92 | | *** |

***p<.001, **p<.01, *p<.05, †p<.1

[a]11% of children had a reported activity limitation at Time 1

Table 2. Fit Statistics of Univariate Unconditional Latent Growth Curve Models of Child Activity Limitations, Maternal Health, Maternal Labor Force Participation, and Household Poverty Status[a]

| | $\chi^2$ (df) | | RMSEA | CFI | TLI |
|---|---|---|---|---|---|
| Child activity limitations | | | | | |
| Intercept | 575.84 | (35) | 0.083 | 0.821 | 0.816 |
| Intercept, slope | 394.96 | (32) | 0.071 | 0.880 | 0.865 |
| Intercept, slope, quadratic | Does not converge | | | | |
| Intercept, slope, quadratic (q variance=0)[b] | 112.74 | (31) | 0.034 | 0.973 | 0.969 |
| Maternal health limitations | | | | | |
| Intercept | 755.67 | (35) | 0.096 | 0.908 | 0.905 |
| Intercept, slope | 114.67 | (32) | 0.034 | 0.989 | 0.988 |
| Intercept, slope, quadratic | Does not converge | | | | |
| Intercept, slope, quadratic (q variance=0)[c] | 77.25 | (31) | 0.026 | 0.994 | 0.993 |
| Maternal labor force participation | | | | | |
| Intercept | 2786.68 | (35) | 0.188 | 0.675 | 0.666 |
| Intercept, slope[d] | 293.64 | (32) | 0.061 | 0.969 | 0.965 |
| Intercept, slope, quadratic | Does not converge | | | | |
| Intercept, slope, quadratic (q variance=0) | 290.01 | (31) | 0.061 | 0.969 | 0.965 |
| Household poverty status | | | | | |
| Intercept | 356.63 | (35) | 0.064 | 0.961 | 0.960 |
| Intercept, slope[e] | 67.08 | (32) | 0.022 | 0.996 | 0.995 |

[a]A root mean square error of approximation (RMSEA) of less than 0.05 is considered a good fit, while values of less than 0.08 are considered marginally good fit (Kline 2005). The comparative fit index (CFI) and the Tucker-Lewis index (TLI) each compare the fit of the baseline model (the model with no relationships specified among variables) and the estimated model (they differ in how they account for degrees of freedom), where values less than .90 suggesting poor fit and values greater than 1 (for the TLI, the CFI is capped at 1) possibly suggest overfitting the model (Bollen and Curran 2006).

[b]Model retained as best-fitting model of the trajectory of child activity limitations.

[c]Model retained as best-fitting model of the trajectory of maternal health limitations.

[d]Model retained as best-fitting model of the trajectory of maternal labor force participation, as chi-square difference is not significant and other fit indices remain the same in the less parsimonious model.

[e]Model retained as best-fitting model of the trajectory of household poverty status, as the slope of the trajectory is not significant (although the variance around the slope is).

Table 3. Parameter Estimates and Standard Errors of Univariate Unconditional Latent Growth Curve Models of Child Activity Limitations, Maternal Health, Maternal Labor Force Participation, and Household Poverty Status

| | Mean (s.e.) | | Variance (s.e.) | |
|---|---|---|---|---|
| Child activity limitations | | | | |
| Intercept growth factor | Fixed at 0 | | 0.238 | (0.028) |
| Linear slope growth factor | 0.170 | (0.011) | 0.001 | (0.000) |
| Quadratic slope growth factor | -0.009 | (0.001) | Fixed at 0 | |
| Maternal health limitations | | | | |
| Intercept growth factor | Fixed at 0 | | 0.523 | (0.490) |
| Linear slope growth factor | 0.119 | (0.018) | 0.002 | (0.001) |
| Quadratic slope growth factor | -0.005 | (0.001) | Fixed at 0 | |
| Maternal labor force participation | | | | |
| Intercept growth factor | Fixed at 0 | | 0.657 | (0.042) |
| Linear slope growth factor | 0.097 | (0.005) | 0.007 | (0.001) |
| Household poverty status | | | | |
| Intercept growth factor | Fixed at 0 | | 0.618 | (0.038) |
| Linear slope growth factor | -0.010 | (0.013) | 0.002 | (0.000) |

Table 4. Covariances Among the Intercepts and Slopes of the Bivariate Latent Growth Curve Models for Child Activity Limitations and Maternal Health and Socioeconomic Factors[a]

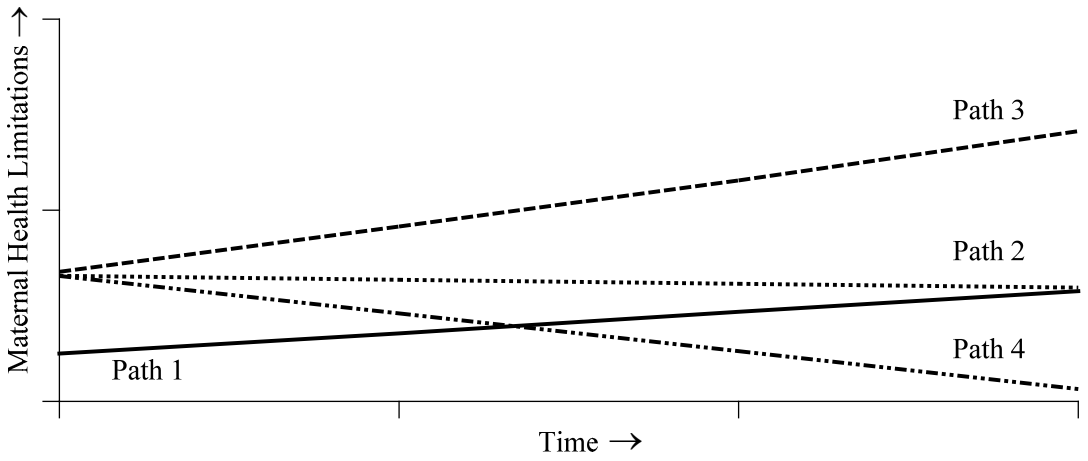
| | Maternal Heath Limitation | | | Maternal Labor Force Participation | | | Household Poverty Status | | |
|---|---|---|---|---|---|---|---|---|---|
| Covariances between growth factors | Coef. | (s.e.) | | Coef. | (s.e.) | | Coef. | (s.e.) | |
| Intercepts | 0.102 | (0.027) | *** | -0.053 | (0.020) | ** | 0.028 | (0.029) | |
| Linear slopes | 0.000 | (0.000) | | 0.000 | (0.000) | | -0.001 | (0.000) | |
| Child activity limitation intercept and linear slope | -0.013 | (0.003) | *** | -0.012 | (0.003) | *** | -0.012 | (0.003) | *** |
| Maternal outcome intercept and linear slope | -0.015 | (0.003) | *** | -0.021 | (0.003) | *** | -0.010 | (0.005) | * |
| Child activity limitation intercept, maternal outcome linear slope | -0.002 | (0.002) | | 0.000 | (0.002) | | 0.004 | (0.004) | |
| Maternal outcome intercept, child activity limitation linear slope | -0.002 | (0.003) | | 0.004 | (0.002) | * | 0.001 | (0.003) | |

***p<.001, **p<.01, *p<.05

[a]Unstardardized coefficients are covariances among the disturbances of each growth factor because time-invariant covariates are included in the model estimation. Note that there are no covariances with the quadratic slope growth factors because the variance of the quadratic growth slope factors was fixed at 0.

Figure 1. Hypothesized over-time relationships among repeated measures

1a. The effect of child activity limitations on trajectories of maternal health limitations




1b. The effect of maternal labor force participation on trajectories of child activity limitations

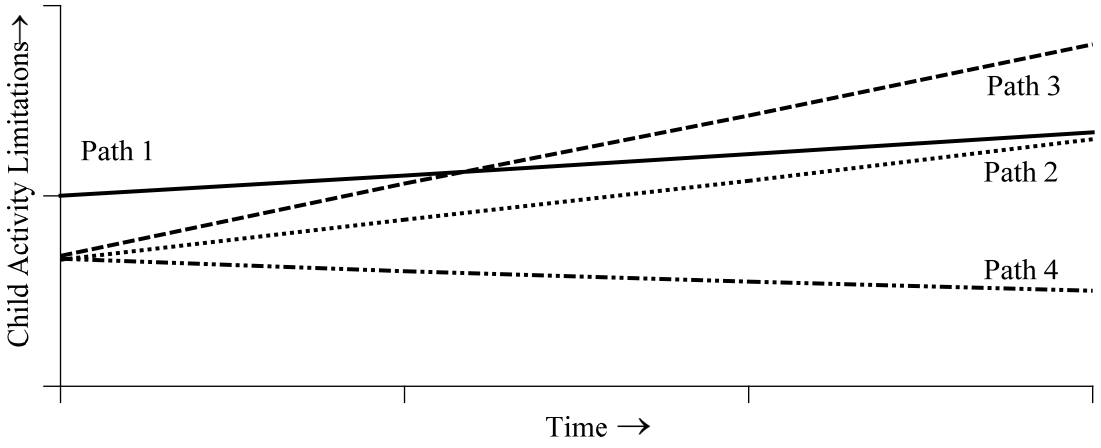


Figure 2. Path Diagram of a Bivariate Latent Curve Model for Two Repeated Measures with Exogenous Covariates and Covariances among the Disturbances of the Growth Factors