

**The Effect of Adolescent Academic Achievement and School Stress on Inflammation:  
Sex Differences across School Contexts**

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September 21, 2012

## **Extended Abstract**

### *Introduction:*

The link between education and physical health is well established in sociological literature, as higher educational attainment has been associated with better self-rated health, improved physical functioning, and lower mortality rates compared to those with less education (Ross & Wu 1996; Ross & Mirowsky 1999; Herd 2010). However, the particular social and biological mechanisms that underlie the relationship between education and health continue to be debated, leaving a critical gap in his area of research. First, prior studies on education and health focus on educational attainment as a primary indicator of overall educational quality, thus conceptualizing education as a primarily material resource that determines future economic opportunities and in turn impacts health trajectories. Meanwhile, little research has assessed the impact of individual academic and social experiences within educational systems, and whether the impact of these experiences differs by sex. This alternative perspective emphasizes a life course approach to understanding health in which individual propensities, efforts, and socialization within schools affect risk and protection from illness. Furthermore, prior research on education and health does not consider the impact of school-level factors on health, thus neglecting to account for how collective experiences within schools have the capacity to influence individual development. Finally, no prior research on education and health use biological markers to identify health disparities in early adulthood. Several recent studies have found a relationship between educational attainment and biological indicators of inflammation late in the life course (Loucks 2006; McDade 2006); however, assessing the effect of education on inflammation in a younger sample would allow for the identification of health risk long before the emergence of physical symptomology.

To address these gaps in research, the current study uses the National Longitudinal Study of Adolescent Health (Add Health) to assess the effect of academic achievement, school connectedness, and school strain on CRP expression in early adulthood, and investigates whether school-level measures of these academic and social factors moderate individual-level associations. Since adolescence is a particularly crucial time for both social development and the formation of career expectations, school experiences during adolescence are expected to have a profound effect on later health. Furthermore, C-reactive protein is a strong candidate in identifying the biological basis of the relationship between educational experience and health, as recent literature has linked chronically elevated CRP and other inflammatory markers to psychosocial stress caused by poor social relations and socioeconomic instability (Jousilahti 2003; Loucks 2006; Uchino 1996). With this prior research in mind, I hypothesize that academic and social experiences in adolescence have the capacity to either protect individuals or increase risk of immune dysregulation early in the life course, thus emphasizing the role of education in providing a setting for both academic and social learning that sets the path for future health.

### *Data and Methods*

The data used to examine the relationships outlined above are from the National Longitudinal Study of Adolescent Health, which is a nationally representative, school-based sample of 20,745 adolescents that were first interviewed in grades 7-12 during the 1994-95 academic year. The sampling frame for Add Health included all high schools in the United States, and a total of 132 schools were selected to participate in the survey. Respondents were followed for four survey waves, with the most recent survey conducted in 2008 when respondents were between the ages of 24 and 32. The analytic sample in this study is limited to

8,001 respondents that participated in both Waves I and IV of Add Health and had complete data for all variables included in this analysis.

*C-reactive protein* (CRP) was collected and measured from blood spots in Wave IV as an indicator of chronic inflammation. CRP levels were separated into three categories based on clinical cutoff points that are used to gauge risk of cardiovascular disease: < 1.0 ug/ml is the healthy CRP range; 1.0 – 3.0 ug/ml indicates low-grade, chronic inflammation; and 3.0 – 10.0 ug/ml indicates high-grade, chronic inflammation. Those respondents with CRP greater than 10.0 ug/ml were dropped from analysis to exclude those with CRP levels that suggest acute infection.

Four indicators of academic and school social experiences were used in this analysis. *Academic achievement* was captured through student reports of grade point average in Wave I. Values ranged from 1 to 4, with higher values reflecting higher grades. The *school connectedness* scale was constructed from three items in the Wave I in-school survey: respondents were asked how much they feel “close to people at this school,” “a part of this school,” and “happy at this school.” Response categories ranged from (1) strongly agree to (5) strongly disagree, and were reverse coded for analysis so that higher scores reflect higher connectedness. School stress was captured through two separate scales that are indicative of different elements of stress: *school social strain* and *academic stress*. School social strain is the sum of two survey items that ask how often respondents had trouble “getting along with teachers” and “getting along with students,” with response categories ranging from (0) never (1) just a few times (2) about once a week (3) almost everyday (4) everyday. Academic stress is the sum of two survey items that ask how often respondents had trouble “paying attention in school” and “getting homework done,” with the same range of response categories as previously described. Covariates for demographic characteristics and health behaviors include sex, age,

family income and family structure at Wave I, educational attainment at Wave IV, body mass index, and smoking.

Ordinal logit regression models were run to evaluate the associations between each individual measure of academic achievement, academic stress, school connectedness, and school social strain from Wave I and levels of CRP in Wave IV. The sample was also stratified by sex to identify whether associations varied by sex. A multilevel model will be constructed to determine whether school-level academic achievement, school connectedness, and school stress moderate individual-level associations. Multilevel assessments will include additional controls for school-level socioeconomic status and urbanicity.

### *Results and Findings*

Preliminary analyses indicate that academic achievement has an inverse relationship on CRP levels in an unadjusted model (OR=0.84; 95% CI, 0.79-0.90); however, adjustment for additional covariates attenuated this relationship. Stratification by sex reveals that the association between academic achievement and CRP was more pronounced in males than in females, as the addition of all covariates diminished the relationship in females, while the relationship in males remained significant (OR=0.89; 95% CI, 0.80-0.98). Furthermore, school connectedness had no significant effect on CRP levels, while school social strain significantly increased risk of high CRP in the initial bivariate model (OR=1.02; 95% CI, 1.01-1.04), but lost significance after incorporation of additional covariates. Similar to academic achievement, the relationship between school social strain was more distinct in males than in females, as males continued to have significantly elevated CRP after the addition of all covariates (OR=1.029; 95% CI, 1.00-1.06), while additional covariates attenuated this relationship in females.

These initial findings indicate that academic achievement as measured by grade point average and school social strain are most predictive of CRP levels in adulthood, suggesting that positive and material aspects of adolescent academic experiences are a significant protective factor for future health, while negative social experiences in schools are predictive of adverse health outcomes. Furthermore, these results suggest that males are most affected by the protective effect of high academic achievement, but are also most at risk for the adverse health effects of higher social strain in school. Additional analyses will expand on these preliminary results to determine whether school-level academic achievement, school connectedness, and school stress moderates individual-level relationships as well as sex differences. This multilevel approach conceptualizes adolescent social and intellectual development as an interactive process with environmental contexts, thus providing a more comprehensive foundation for the study of education and health.

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