

Childhood adversity and adolescent inflammation and health outcomes

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Part I. The evidence base

The psychobiological outcome. In this paper, we provide an overview of links between low childhood socioeconomic status (SES) and inflammatory and health outcomes, primarily in childhood. Children from low SES backgrounds are more likely to experience juvenile violence, including childhood maltreatment and neighborhood violence (Crouch et al., 2000; Herrenkohl & Herrenkohl, 2007). Thus low SES provides a broad umbrella framework for understanding the effects of juvenile violence exposures on health.

The psychobiological outcome and physical health. We discuss links to both childhood health outcomes, as well as to physiological pathways linked to disease risk according to stress models of disease. Activation of the hypothalamic pituitary adrenal axis and the sympathetic nervous system with stress leads to the release of hormones such as cortisol, epinephrine, and norepinephrine, which over time with repeated exposures, accumulate to contribute to the pathogenic processes that drive cardiovascular diseases (CVD), including systemic inflammation, high blood pressure, obesity, and insulin resistance (Brotman et al., 2007; Everson-Rose & Lewis, 2005; Rozanski et al., 2005). High levels of systemic inflammation, high blood pressure, obesity, and insulin resistance in turn all predict CVD morbidity and mortality (Guh et al., 2009; Lindmark et al., 2001; Ridker et al., 2000a; Ridker et al., 2000b; Vasan et al., 2001). Moreover, the accumulation of these characteristics in constellations of risk factors such as metabolic syndrome, predict even more strongly an increased risk of CVD later in life (Lakka et al., 2002; Morrison et al., 2007; Ridker et al., 2003).

Research literature on childhood socioeconomic status, inflammatory markers, and health. Abundant epidemiological data link low childhood socioeconomic status to clinical childhood health outcomes (see (Chen et al., 2002; Starfield et al., 2002a; Starfield et al., 2002b)), with some evidence linking low childhood SES to inflammation measures. With respect to health outcomes, adolescents growing up in low SES environments experience greater mortality risk, although this is primarily from acute causes such as pneumonia and influenza, fire, poisoning, and homicide (Nelson, 1992; Nersesian et al., 1985). Low SES is also associated with poorer self-rated physical health status, more physical illnesses, and greater disabilities in adolescents (Emerson et al., 2006; Goodman, 1999). With respect to illnesses, low SES is consistently associated with greater childhood asthma impairment, including more frequent emergency department visits (Maziak et al., 2004; Simon et al., 2003), more frequent hospitalizations (Dales et al., 2002), greater symptoms (Ernst et al., 1995), and more severe asthma (Mielck et al., 1996). Low SES also is associated with a greater likelihood of childhood obesity (Lamerz et al., 2005; Lobstein et al., 2004; Wickrama et al., 2006).

With respect to inflammation and metabolic risk, low SES has been associated with multiple metabolic risks among adolescents, including higher insulin and glucose, higher LDL cholesterol, waist circumference, and body mass index (BMI) (Goodman et al., 2005). Low SES among adolescents also has been linked to inflammatory markers related to coronary heart disease risk, such as elevated C-reactive protein (CRP) and interleukin-6 (IL-6) (Murasko, 2008), although the evidence base is more substantial in adults (Hemingway et al., 2003; Owen et al., 2003; Panagiotakos et al., 2005). Finally, low SES is also linked to disease-relevant inflammatory markers in children and adolescents. For example, among children with asthma, lower SES is associated with greater stimulated production of asthma-relevant cytokines and higher eosinophil counts, both of which drive asthma inflammatory processes (Chen et al., 2003; Chen et al., 2006).

Establishing causality. Two primary lines of work can be used to establish that low SES is associated causally with increased physiological risk and poor health outcomes. The first is animal studies that have investigated the effects of social hierarchies on health and biological processes. For example, studies of monkey hierarchies repeatedly demonstrate that being low on the social hierarchy (i.e., submissive as opposed to dominant), particularly in stable animal hierarchies and among females, is associated with a greater risk of atherosclerosis and elevations in hormones such as glucocorticoids (Kaplan & Manuck, 1999; Sapolsky, 2005).

The second is human longitudinal studies in which SES precedes the health or psychobiological outcome, thus establishing evidence for directionality. These studies document that low SES at earlier points in the lifespan predict future disease risk (Galobardes et al., 2006; Miller et al., 2011), and document that change in SES predicts later morbidity and mortality (Hart et al., 1998; McDonough et al., 1997).

Effect moderation. Despite the fact that low childhood SES is a clear risk factor for disease, there are a number of low SES children who do not go on to develop poor health later in life. Why might this be? That is, why do some children not get sick even in the face of repeated and severe stressors such as juvenile violence exposure? Evidence suggests that in fact this type of resilience is not uncommon, and hence is important to understand. In one study of adults, individuals from different SES backgrounds were exposed to a virus while quarantined and followed clinically to track signs of the common cold. Although low SES individuals were more likely to develop colds than high SES individuals, fewer than 50% of those in the lowest SES category exhibited colds, despite all having been experimentally exposed to the virus (Cohen et al., 2004). In fact, a number of researchers have argued that such resilience is more the norm than an anomaly (Bonanno, 2005; Masten, 2001). What is it, then, that can protect the physical health of a subset of children facing adversities such as violence exposure?

We recently articulated a model of the psychological characteristics that could serve protective functions in a physical health context. Because much of the literature on resilience has focused around psychological adaptation (Luthar, 2006; Masten & Obradovic, 2006; Rutter, 1993), for those interested in physical health effects, it is important to identify psychological characteristics that plausibly have effects on the types of physiological systems identified earlier that have implications for disease.

In a recent theoretical paper, we proposed that a constellation of characteristics labeled “shift-and-persist” will be particularly beneficial for the physical health of low SES children (Chen & Miller, 2012; Chen, in press). The model begins by outlining how a lifetime of facing constraints with limited options leads those living in a low SES context to place value on the ability to adjust oneself in response to stressors through emotion regulation strategies such as reappraisals (*shifting*). At the same time, in this context, successful adaptation entails enduring adversity with strength, finding meaning in difficult situations, and maintaining optimism in the face of adversity (*persisting*). This combination of approaches to dealing with adversity reduces physiological responses to stressful situations acutely, and over the long-term, mitigates the progression of pathogenic processes leading to chronic diseases such as CVD.

Shifting entails strategies aimed at adjusting the self to the external environment through strategies such as reframing the meaning of a stressor in less threatening ways. Coping via efforts that emphasize regulating the self may be beneficial because it represents a good fit with the types of constrained situations that are often encountered by those low in SES. Empirical research shows that when low SES individuals make active efforts to control situations- the opposite of shifting- a physiological toll is exacted. For example, low SES adults who are high on John Henryism (the tendency to use active coping efforts for dealing with stressors that are largely uncontrollable) show higher blood pressure and increased risk of hypertension compared to those who are low in SES and low in active coping (James et al., 1987).

Persisting involves enduring adversity with strength, by finding meaning in difficult situations and maintaining optimism about the future. The search for meaning allows people to maintain hope, particularly when confronting adversity (Updegraff et al., 2008). Moreover, among only those low in SES, higher purpose in life (similar to meaning in life) was associated with lower levels of IL-6. Purpose in life was not associated with IL-6 in high SES adults (Morozink et al., 2010), suggesting that the ability to find meaning may be particularly important among those confronting ongoing adversities. Similarly, among those low in SES, those who were also low in pessimism (or conversely, high in optimism) had ambulatory blood pressure levels comparable to high SES individuals, with these levels being lower than those in low SES individuals who were low in optimism/high in pessimism (Grewen et al., 2000).

But given that each of these measures has been the target of investigation in its own right in previous research, is there anything unique about manifesting the combination

of shift and persist approaches? We argue that it is in fact the combination, that is critical- that is, possessing both an approach that values shifting the self in response to stress together with persisting with hopes for one's future will be more beneficial than either trait on its own for physiological responses to stress among those low in SES. Hence the label that we use, "shift-and-persist," is intended to connote the fact that it is the combination of these characteristics, rather than either one on its own, that is uniquely beneficial to health among those low in SES.

In two studies from our research group, we documented disease-related benefits of shift-and-persist for those low in childhood SES. In the first study, the childhood circumstances of a national sample of adults were assessed. We created an index of cumulative physiological risk (allostatic load) based on 24 different measures across seven physiological systems. Shift and persist was measured via questionnaires probing coping styles and future orientation. We found a 3-way interaction between childhood SES, shift, and persist in predicting cumulative physiological risk in this sample. That is, there was a 2-way interaction between shift and persist found in low SES, but not in high SES, participants. The 2-way interaction was such that the lowest physiological risk was found amongst those low SES participants who were high on both shifting and persisting. In contrast, there was no interaction between shift-and-persist and allostatic load among those from high childhood SES backgrounds (Chen et al., 2012).

In a second study using a clinical pediatric sample, we investigated the effects of shift-and-persist in a sample of children diagnosed with asthma. Among those low in SES, higher shift-and-persist scores were associated with lower levels of asthma inflammation. In addition, among low SES children, higher shift-and-persist scores prospectively predicted less asthma impairment (fewer school absences, less rescue inhaler use) six months later, controlling for baseline levels. Low SES children who were high on shift-and-persist displayed inflammatory and clinical profiles more similar to high SES children with asthma than to low SES children who were low in shift-and-persist. In contrast, shift-and-persist did not benefit high SES children with asthma (Chen et al., 2011).

Taken together, these findings suggest that understanding psychological characteristics related to shift-and-persist in children who have experienced adversities in life (e.g., juvenile violence exposure) may help us identify naturally occurring protective factors that buffer these at-risk children from detrimental physical health outcomes.

Effect mediation. A number of previous papers have discussed potential mediators of the SES-health relationship, at the individual psychological level (e.g., stress, negative emotions, personality characteristics; Chen et al., 2002; Matthews et al., 2010), at the individual behavioral level (e.g., health behaviors; Goldman & Smith, 2002; Lantz et al., 1998), at the family psychosocial level (e.g., family conflict and parenting; McLoyd, 1998; Repetti et al., 2002), and at the neighborhood level (e.g., social capital; neighborhood noise and crowding; Evans & Kim, 2010; Leventhal & Brooks-Gunn,

2000). As well, several papers discuss the contribution of both the physical (e.g., the built environment; pollution) and the social (e.g., community connections) environment to the SES gradient (Diez Roux & Mair, 2010; Evans, 2004; Schreier & Chen, under review).

Part II. Implications for prevention and intervention

Implications for primary prevention of low childhood SES. Efforts to eradicate poverty, while valiant, are probably not that realistic in our society. That said, one intriguing intervention study suggests that improving economic circumstances could have benefits for physical health. In this study, families were randomly assigned to receive either a housing voucher with the requirement that they move to a low-poverty neighborhood, a housing voucher with no stipulations attached (traditional voucher), or to a control group that did not receive a housing voucher. When body mass index (BMI) and glycosylated hemoglobin were measured 10 years later, researchers found that elevated BMI and glycosylated hemoglobin were found at lower rates in the low-poverty voucher group, whereas the traditional voucher and control groups did not differ from each other (Ludwig et al., 2011). This suggests that if there were ways to move low SES families out of poverty and into better neighborhoods, this might not only reduce juvenile violence exposures but could possibly also have long-term health benefits.

Implications for secondary prevention and treatment of health outcomes among those low in SES. Nonetheless, given that poverty reduction efforts might not be the target of choice for our think-tank group, there remains the possibility that we could devise recommendations for altering psychosocial characteristics amongst those who are currently living in low SES environments. This approach assumes that it will be difficult to change the exposures themselves (e.g., juvenile violence), and rather emphasizes responses to these adversities and how to optimize responses from a physical health perspective.

One potentially promising, but untested, idea is to teach shift-and-persist values to low SES children. Given that we find that shift-and-persist naturally occurs in a subset of low SES individuals, this suggests that it would be feasible to promote this characteristic in other low SES individuals (as opposed to targeting psychosocial factors that have been shown to be protective in studies of largely middle to upper SES populations, but which might not translate well to low SES circumstances).

How, then, could we begin to promote shift-and-persist values in children facing adversities such as juvenile violence? In our review, we argue that key to the development of shift-and-persist strategies early in life is the presence of positive role models (Chen & Miller, 2012). Role models refer to important figures who have a significant influence on a child's life, and who provide support and inspiration - e.g.,

parents, extended family members, teachers. Role models can help low SES children develop beliefs that others can be trustworthy and dependable (Yates et al., 2003), which in turn will shape reappraisals of stressful situations. Role models also model adaptive emotional and behavioral responses to stressors, teaching effective emotion regulation to children (Eisenberg et al., 1998). Finally, role models help orient youth toward their futures, promoting optimism and meaning-making (Bryant & Zimmerman, 2003). Hence in the midst of difficult life circumstances, those low SES children who are able to find role models may more easily adopt shift-and-persist values as a function of what their role models teach them. One intervention study that is tangentially related found that among children who had been maltreated, teaching positive parenting skills to foster parents produced greater declines in children's cortisol compared to maltreated children in foster care whose parents did not participate in the program (Fisher et al., 2000). Hence to the extent that we can connect children who have experienced adversities such as juvenile violence exposure to role models, this may facilitate shift-and-persist strategies, reduce acute physiological responses to stressors and prevent longer-term pathogenic processes from accelerating, even if the adversities themselves cannot be changed.

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