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A growing body of evidence documents the substantial effects on health of social policies whose focus is not on health per se, such as those in this volume that explicitly target areas such as income support, housing, civil rights, and other social policy arenas. In this chapter, we examine evidence for the health effects of policies designed to address human development, with a particular emphasis on early childhood development policies. Because human development policies have typically played a minor role in policy discussions about health, we first define their scope and outline a general conceptual framework to support their relevance. We then review evidence to illustrate their connection with health.

Human development policies include parental leave policies; labor laws that determine work conditions, hours, benefits, and flexibility of workplaces; policies determining the availability, cost, and quality of child care and early childhood education programs; funding for, access to, and the social composition, quality, and content of all levels of public education; public assistance programs and eligibility for and levels and types of assistance provided; state and local expenditures on other public services such as police and corrections, housing and community development, and community recreational facilities and resources; and others. Human development policies shape the most proximal social structures, institutions, and material conditions of daily life that may determine individual health across multiple domains through the life course and which may, in the aggregate, determine population-level distributions of health outcomes. Although we do not explore the health effects of all of these human development policies, they indicate the range of policy decisions whose impact on health needs to be better understood.

Socioeconomic gradients, the differential distribution of health outcomes across subgroups of a population having differing levels of socioeconomic status (SES), have long been observed across multiple domains for population well-being: morbidity and mortality outcomes (Kunst and Mackenbach 1994; Kaplan and Keil 1993; Kunst and Mackenbach 1992; Antonovsky 1967), health behaviors (Lantz et al. 2001; Lynch, Kaplan, and Salonen 1997), psychosocial well-being (Muntaner et al. 2004; Tremblay 1999), and cognitive performance, literacy, and academic achievement (Willms 1999a; Brooks-Gunn, Duncan, and Rebello Britto 1999). We have

argued that this full range of health outcomes -- physical, mental, and psycho-emotional health and literacy and academic competence -- may be fruitfully combined within a multidimensional omnibus indicator termed “developmental health” (Keating and Hertzman 1999) in order to fully capture the multiple dimensions of individual and population health.

Recent reviews of contemporary research support the claim that health throughout the life course is strongly influenced by social and developmental determinants, and that many such determinants are not disease-specific, in that they may be associated with multiple health outcomes through the life course. The contribution of developmental determinants to health is increasingly recognized in epidemiologic, developmental, and economic analyses (Galobardes, Lynch, and Davey Smith 2004; Kuh and Ben-Shlomo 2004; Smith 2004; Case, Lubotsky, and Paxson 2002; Harper et al. 2002b; Kaplan et al. 2001a). The evidence for this link is increasingly substantial, even if the underlying mechanisms remain unclear.

W. Thomas Boyce and Daniel P. Keating (2004) described a set of linked questions that articulate the connections from observations of SES gradients in developmental health to the mechanisms underlying these observed gradients to the policy implications of this integrated understanding:

“Is there evidence that experiences in early development have life course consequences for health? If so, are these consequences substantial enough (that is, account for enough variance in subsequent health outcomes) to warrant significant investment? If so, is there evidence that changes in childhood circumstances show positive life course benefits to health, to test whether observed associations are more than merely correlational? If so, is there theory and evidence that affords an understanding of the underlying developmental mechanisms, such that interventions can be properly guided and unintended harm avoided? Finally, are the identified interventions feasible in current policy contexts, and what arguments can be made to make them more viable?” (p. 428)

In this chapter, we examine associations between human development policies and developmental health outcomes to begin to formulate systematic answers to these questions. We explore the extent to which human development policies may influence individual developmental health outcomes, socioeconomic gradients, and overall population health. Specific biodevelopmental mechanisms that may underlie social disparities in developmental health will also be examined. Two general levels of educational and human development policies will be considered: early childhood intervention programs and national educational and human development policies that form the context and background for early childhood intervention programs implemented in the United

States. While we will focus primarily upon the United States, we will draw upon international research whenever possible.

We will first review general findings on socioeconomic gradients that indicate the general importance of developmental determinants for population developmental health. We will next consider several processes through which disparities in early childhood circumstances may become “embedded” in the brain and biology of individuals, such that they can be expressed in such a wide range of life course outcomes (Boyce & Keating 2004). We then examine specific early child development policies with regard to the direct and indirect health effects of experimental and quasi-experimental interventions to enhance child development, as well as the health effects of larger scale, national policies in the areas of education and human development. We conclude with a discussion of the importance of human development policies to achieving goals of improved population health.

Socioeconomic Gradients

A socioeconomic gradient describes the relationship between a health outcome and a measure of socioeconomic status (SES) for individuals residing in a specific community during a specific time period (Willms 2003c). Gradients are evident across all measures for SES, indicators for an individual or family’s relative location within an encompassing social structure: education, income, wealth, and occupational status. Socioeconomic gradients are also notably evident across the full range for each measure of SES, not concentrated below a discrete poverty or deprivation threshold demarcating increased risk (Marmot et al. 1991). Socioeconomic gradients offer a summary measure of the average level and distribution of a developmental health outcome across a specified measure of SES for a particular population.

A growing body of research has documented variation among socioeconomic gradients in developmental health outcomes within and between countries (Willms 2004; Cavelaars et al. 2000; Mackenbach et al. 2000; Willms 1999a; Cavelaars et al. 1998). While epidemiologic research has generally focused upon describing socioeconomic gradients and identifying the social determinants of disease, much less attention has been paid to the underlying social processes that may differentially distribute these social determinants within and between populations and their constituent subgroups (Graham 2004). Indeed, it has been argued that such distributional processes have in recent history supplanted absolute material deprivation and sanitation as primary determinants of population health and social disparities in many countries (Fogel 2003).

The field of education offers a rich body of methodological and empirical literature examining intra- and inter-country variation in socioeconomic gradients for measures of literacy and academic performance. Several consistent themes arise from a review of the literature. First, international evidence from the Organisation for Economic Co-operation and Development (OECD) countries indicates a high level of inter- and intra-country variation for levels and slopes of socioeconomic gradients for quantitative skills, reading, and overall literacy (Programme for International Student Assessment 2004; Willms 2004; Willms 1999a). Second, countries that have higher levels of academic performance typically have flatter slopes and relatively higher levels of achievement and literacy among adults and children from lower socioeconomic backgrounds. Third, inter-country differences for academic performance and literacy outcomes among students from higher SES households tend to be much smaller than those observed for children having parents with lower levels of socioeconomic status.

This pattern of decreasing variation or convergence across countries or jurisdictions for outcomes observed among individuals having higher levels of SES has been described as the “hypothesis of converging gradients” (Willms 2003b). While youth and adults from higher SES backgrounds consistently exhibited high and comparable levels of literacy and academic performance across countries and smaller constituent jurisdictions, literacy and achievement outcomes for students from more disadvantaged backgrounds varied considerably across countries, states, and provinces (Willms 2004; Willms 1999b; Willms 1999b; Willms 2003a). Figure 1, which shows relationships between literacy scores and parental education for youths aged 16-25 in seven OECD countries, illustrates this pattern of converging socioeconomic gradients. Average levels of achievement and literacy exhibit inverse associations with the slope of the gradient: countries and jurisdictions having the highest average levels of achievement exhibited shallower gradients and consequently lower levels of inequality of outcomes across measures of SES.

[INSERT FIGURE 1 ABOUT HERE]

Epidemiologic studies of population-level health outcomes across OECD countries have also noted lower average levels of mortality and inequality across levels of SES among countries having more egalitarian educational and human development policies (Vagero and Erikson 1997a; Kunst and Mackenbach 1994; Vagero and Lundberg 1989). Countries having higher average levels of literacy and lower inequality across socioeconomic groups for literacy and educational outcomes also have lower levels of inequality for adult

mortality (Vagero and Erikson 1997b; Vagero and Lundberg 1989) and lower infant mortality rates (Navarro and Shi 2001). Societies having the highest average levels of population health and flatter socioeconomic gradients tend to be those that have been most successful in ensuring the well-being of the most disadvantaged subgroups of the population.

These findings suggest that the adverse effects of low SES on developmental health outcomes are neither uniform across societies nor necessarily inevitable. While groups having lower levels of SES do consistently exhibit higher risk for adverse developmental health outcomes across all known societies, the extent of inequality across levels of SES differs substantially across social contexts. Inequalities for developmental health outcomes are socially produced. The differing socioeconomic gradients observed in developmental health outcomes across countries and jurisdictions may reflect the influence of differing human development policies that may underlie and shape the social distributions of risk factors and determinants of developmental health outcomes across populations and their constituent subgroups.

Human development policies may be potential points of leverage for addressing health inequalities and improving overall population health. Adult educational attainment is prior to and predictive of employment status, occupational opportunities, working conditions, and income; these are in turn associated with many adult health behaviors and outcomes. Parental education is also significantly associated with many child developmental health outcomes (Chen, Matthews, and Boyce 2002; Brooks-Gunn, Duncan, and Rebello Britto 1999; Tremblay 1999; Willms 1999a). Childhood SES also has significant effects on a number of adult developmental health outcomes including cognitive function (Kaplan et al. 2001b), psychosocial functioning (Harper et al. 2002a), and physical health outcomes such as cardiovascular disease, hemorrhagic stroke and stomach cancer (Galobardes, Davey Smith, and Lynch 2005; Galobardes, Lynch, and Davey Smith 2004; Hayward and Gorman 2004).

Human development policies, which may determine distributions of educational attainment and other measures of SES across populations, may concomitantly shape underlying distributions of the social determinants of health and disease across the life course through a variety of potential pathways. Such policies may differentially distribute access to physical, material, educational, financial, social, educational and informational resources needed for optimal development. They may also determine social topologies: who interacts with whom. Social interactions may influence developmental health outcomes through role model effects, local norms of behavior,

social and informational networks, and peer group influences (Durlauf 2001). It is also essential to consider the mechanisms that may be molded and calibrated by the social processes shaped by human development policies in order to understand how these social forces “get under the skin” to be expressed in a wide range of developmental health outcomes across the life course (Boyce & Keating 2004; Worthman & Kuzara, 2005).

From Child Development to Health: Getting Under the Skin

Identifying the precise links connecting social disparities to differences in actual social transactions, to the shaping of biodevelopmental processes, and to the ongoing effects of resulting biodevelopmental variability on developmental health outcomes across the life course, constitutes a major interdisciplinary program of research. The goal of such a research program would be to satisfy the constraints arising from the nature of empirically observed social gradients in health (especially their pervasiveness across many types of health outcomes and their life course durability) and from our understanding of potential biodevelopmental mechanisms that could generate these patterns. We define candidate biodevelopmental systems as those which (1) are responsive to differences in early life experience, (2) exhibit the long term effects of these differential early life experiences, and (3) influence developmental health outcomes. We briefly note three candidate biodevelopmental systems that show promise of satisfying these criteria.

The first of these candidate systems focuses on the notion of psychosocial control that figures prominently in some contemporary theories of social disparities and health (Marmot 2004). The functioning of the stress response system (biologically based in the limbic hypothalamic-pituitary-adrenal [L-HPA] system) is a prime candidate for understanding the biodevelopmental origins and effects of this psychosocial factor. Our understanding of how the L-HPA system develops and functions is increasing rapidly (Gunnar and Donzella 2002). There is good evidence that L-HPA function is shaped by early social experience in both animal and human models, both by normative variations in parental warmth and sensitivity and by more extreme variations such as neglect and abuse. There is also strong evidence from animal models (and increasingly from human studies) that such early patterning has long term effects on the functioning of the L-HPA system, and that normative variations in the experience of uncertainty (that is, perceived lack of control) and social evaluation (that is, status and dominance relationships) during adulthood evoke strong cortisol response (Dickerson and Kemeny 2004). The final link is the increasingly established link between excess or dysregulated cortisol response and

deleterious effects on numerous organs, with consequences for both morbidity and mortality (McEwen, 2005; Sapolsky, 2005; Worthman & Kuzara, 2005).

A second candidate system focuses on the notion of social participation, belonging, and connection. The psychosocial aspects of this have been implicated in the literature on social disparities and health; the biodevelopmental aspects seem to play out most prominently in disruptions to the functioning of the serotonergic system (Suomi 2000). Evidence from animal and human studies both point toward disruptions in the attachment relationship between (typically) mother and infant as a primary source of social disruptions in the serotonergic. It is also important to note that there is genetic variation in the serotonergic system (in the serotonin transporter gene, 5-HTTLPR), and that this is expressed in both animal and human studies as a *gene-environment interaction* such that genetic risk is activated *only* in circumstances of disrupted parent-child relationships, through peer-rearing in Rhesus macaques (Suomi 2000) and through a developmental history of abuse/neglect in humans (Caspi et al. 2003). The observed consequences of a disrupted serotonergic system are manifold, including elevated risk for depression, aggression, and substance abuse. Evidence suggests that these may in turn be associated with adult morbidity and early mortality.

A third candidate system focuses on a later developing system that includes aspects of perceived purpose, hope, meaning, and identity. This system is uniquely human, arising as a co-evolution of culture and mind (Donald 2001). The primary focus here is the prefrontal cortex of the brain (PFC), which is disproportionately larger (relative to body-size-corrected brain volume) in humans, both archaeologically and by comparison to contemporary non-human primates. The PFC achieves this differential size largely during the adolescent transition, and is connected in developmental time with increased speed and amount of connections to other brain systems (Keating 2004). The implication is that the achievement of the specifically human level of consciousness involves an increased role of PFC governance of brain and biologic systems. A second implication from the nature of growth (proliferation of new synapses in early adolescence, and pruning of those during later adolescence) is that it is sensitive to developmental experience, in much the same way that early experience shapes brain and biologic systems. The precise connections from these biodevelopmental acquisitions and outcomes in developmental health are more difficult to specify, given the complexity of the system, but there is an

established link from related aspects such as hopelessness or lack of meaning to a range of negative health outcomes (Everson-Rose and Lewis 2005; Everson et al. 2000; Everson et al. 1997; Everson et al. 1996).

This final point raises an important issue about the pattern of developmental determinants. Contrary to caricatures of developmental determinism, experiences throughout the life course continue to influence health. Early adversity may be moderated by later resilience; early advantage may be hampered by later trauma. It is helpful therefore to briefly consider various patterns of developmental effects. Drawing on work by Clyde Hertzman (1999) and Diana Kuh & Yoav Ben-Shlomo (2004), Boyce and Keating (2004) describe three ways in which childhood circumstances may affect health outcomes over the life course.

One pattern progresses through stability of socioeconomic circumstances from childhood to later life, with an accumulation of risk from a variety of sources. In other words, individuals who grow up in more stressful circumstances tend to experience those same circumstances throughout their development. The implication of this *cumulative* pattern is that broad societal differences in the quality of the social and physical environment play a major role in developmental health outcomes, through the overall degree of social partitioning and the SES-related patterns that emerge in early life, and continue. A second set of childhood influences may be thought of as *pathway* effects, constituted by chains of risk or protection. For example, educational attainment plays a substantial role in both subsequent health and social status. Beyond simple continuity, it is likely that the early acquisition of competencies, skills, and dispositions – or “capabilities,” to use Amartya Sen’s (1999, p. 18) term – has direct effects on the pathways leading toward future health, and are contingent on core biodevelopmental acquisitions such as those describe above. Such associations are likely attributable to sequences of linked exposures, in which early risk factors increase the likelihood of subsequent exposures, which in turn augment the probability of encountering others. A third type of influence can be thought of as critical period, sensitive period, or *latent effects*. Even after removing the effects from other, later sources – adult SES, differential developmental pathways, and so on – there is often a non-trivial impact of childhood circumstances on life course health outcomes. For example, the early instantiation of an over-reactive stress response system may affect developmental trajectories through success in selected environments (pathway effects), but in addition, may create a health risk that will become manifest only at a later stage in the life course as stressors accumulate and/or grow more intense (Worthman & Kuzara 2005).

Understanding the underlying mechanisms and the ways in which their effects are manifested improve the prospects for more precisely evaluating the impact of various policies, whether or not they are focused on health per se.

In the remainder of this chapter, we examine available evidence on the impact of human development policies on health. We look at two categories of policy interventions: (1) early childhood intervention programs; and (2) more general national level policies. We consider both direct health effects as well as potential indirect effects on later health through effects on significant pathways associated with attained SES, including cognitive development, education, income, and social participation (employment and rate of incarceration).

Early Childhood Intervention Programs.

Early childhood intervention programs in the U.S. have been designed with the intent of helping low-income children overcome the developmental disadvantages of growing up in poverty and have, with few exceptions, been targeted exclusively to low-income children or children who are otherwise perceived as being at high risk for adverse developmental outcomes. Such interventions would thus be expected to reduce the slope of socioeconomic gradients in developmental health outcomes by improving outcomes among children from low-SES family backgrounds. Drawing upon several excellent reviews of early childhood education programs (Barnett 2002; Currie 2001; Karoly et al. 1998; Barnett 1995), we focus upon two general types of programs: model early childhood demonstration programs and large-scale publicly funded programs. We distinguish between these two types of early childhood programs because of substantial differences in their associated levels of funding and resources; intensity, duration and age of entry; teacher qualifications, training and pay; scale of implementation, and suitability of design for statistical inference.

Model early childhood demonstration programs, many of which have used randomized assignment to define treatment and control groups for evaluation, have had higher cost per child, lower child-teacher ratios, more highly qualified teachers, longer duration, earlier age of entry, and more intensive programming than large-scale publicly funded early childhood programs such as Head Start and the Chicago Child-Parent Centers. For example, the full-day, 50 weeks per year, preschool component of the Carolina Abecedarian Project, which continued for five years from infancy through age 4, cost approximately \$15,000 per child, per year in 1999 dollars (Ramey, Campbell, and Blair 1998; Currie 2001). This model program had a child-teacher ratio that

ranged from 3:1 during infancy to 6:1 during preschool. In contrast, in 1998 it cost \$5,021 for a child to attend a part-day Head Start program for 34 weeks per year (Currie 2001).

The estimation of treatment effects for early childhood intervention programs poses numerous practical and methodological challenges. We would ideally like to estimate the effect of an intervention on children's outcomes compared with what would have been observed for the same group of children had they not attended preschool, holding all else constant. However, we are unable to observe the same child simultaneously attending and not attending a given early childhood program. Accounting for this inability to observe the counterfactual, the same child in the absence of intervention, is one of the primary challenges facing efforts to evaluate the effectiveness of early childhood education programs. Two general types of approaches are used to address this challenge: experimental studies and quasi-experimental studies.

Experimental studies: Experimental studies or randomized controlled trials (RCTs) are generally regarded as the "gold standard" for the estimation of intervention effects. In this study design, each member of a study population is randomly assigned to participate in either a specified early childhood program (the treatment group) or to not participate in the early childhood program (the control or comparison group). If the sample size is sufficiently large and the randomization mechanism is successful, the two groups will be comparable with respect to both observed and unobserved characteristics. The average effect of the intervention can then be estimated by the difference between the average outcomes observed for the treatment and control groups.

Quasi-experimental studies: Quasi-experimental study designs based on observational data are typically used to estimate treatment effects in social science contexts where RCTs would be impractical, unethical, or prohibitively expensive. In observational studies, children are not randomly assigned to early childhood programs. Estimates for the effects of early childhood programs on child outcomes may be biased if the study design fails to adequately control for observed and unobserved family characteristics that may be correlated with both selection into the preschool program and child developmental outcomes. Several commonly used approaches to address selection bias and potential confounding include multivariate statistical adjustment, fixed effects models, instrumental variables, and propensity score methods (Currie 2005; Karoly and Bigelow 2005). Currie provides an excellent review of the strengths and limitations of these study designs and statistical methods (Currie 2005).

We will review findings from quasi-experimental studies of two large-scale publicly funded early childhood programs: the Chicago Child-Parent Centers (CPC) and Head Start. Studies of the effects of the Chicago CPC are based on data collected as part of the Chicago Longitudinal Study (CLS) which includes all children who enrolled in CPCs having preschool and kindergarten programs in 1983. There was significant natural variation in the duration of program participation, with some children participating only in the preschool components while others continued through third grade (range=1-6 years). The comparison group was composed of children who completed all-day kindergarten programs at randomly selected schools serving predominantly low-income families in neighborhoods where CPC services were not available. A school age intervention was also offered during the first three years of elementary school at several of the included project centers. Thus, the CLS uses a 4-way design to assess the relative effects of intensive preschool intervention with and without an enriched curriculum for school-aged children, participation in only the school-aged intervention, relative to a control group that did not receive either stage of intervention.

Studies of the effects of Head Start on child and adult outcomes have had to address a number of formidable challenges. First, the only randomized trial of Head Start began in 2002 (U.S. Department of Health and Human Services 2005). The absence of an experimental design during the implementation of Head Start has greatly complicated the task of defining appropriate comparison groups for the estimation of treatment effects. Children who actually attend Head Start have been found to be especially disadvantaged, even relative to the full sub-population of children defined as eligible to attend Head Start (Oden, Schweinhart, and Weikart 2000; Lee, Schnur, and Brooks-Gunn 1988). Non-comparability of the Head Start and comparison groups can result in a bias against finding positive effects of Head Start participation on child outcomes. Second, the nationwide heterogeneity of funding, locally-defined curriculum content, and program services across both space and time entails that there is not a single, consistent “Head Start program” for evaluation.

The strongest individual-level studies of Head Start have used fixed effects models and data from nationally representative cohort studies to compare outcomes for participants with those for siblings who did not attend the program (Garces, Thomas, and Currie 2002; Currie and Thomas 1999; Currie and Thomas 1995). Fixed effects models are advantageous insofar as they enable researchers to control for observed and unobserved household and maternal characteristics that are assumed to be fixed through time and across siblings.

Evidence for Direct Effects of Early Childhood Programs on Health Outcomes

In this section we review evidence for the existence of direct and indirect effects of early childhood intervention programs on developmental health outcomes. We have restricted our review to model early childhood programs that have used randomized assignment of program participation status, and having relatively large study samples with low levels of sample attrition: the Carolina Abecedarian Project, the Infant Health and Development Program (IHDP), and the Perry Preschool Project. These three demonstration programs had different enrollment criteria: the Carolina Abecedarian Project enrolled low-SES children, the Perry Preschool Project was targeted toward low-SES children who had low IQ scores, and the IHDP, based on the design and curriculum of the Abecedarian Project, enrolled a socio-economically heterogeneous sample of preterm, low birth weight infants.

Our review of outcomes for large-scale publicly funded programs is limited to those having large sample sizes and longer-term longitudinal follow up across multiple sites: the Chicago CPCs and Head Start. Supplemental tables summarizing the characteristics of included early childhood programs and findings for the direct and indirect effects of early childhood programs on developmental health outcomes are included in the working paper version of this chapter and are available at the website for the National Poverty Center at the University of Michigan (<http://www.npc.umich.edu/>) or from the authors.

Model early childhood intervention programs

All three of the included model early childhood programs have examined longer-term effects of childhood program participation on a limited set of adult health behaviors and outcomes. At age 27, Perry Preschool Project program participants were significantly less likely than controls to report smoking cigarettes or drinking alcoholic beverages several times a week, and more likely to report never drinking alcoholic beverages and always wearing seatbelts (Schweinhart, Barnes, and Weikart 1993). At age 40, significantly fewer male Perry Preschool Project participants than control no-program males reported using sedatives, sleeping pills or tranquilizers, marijuana or hashish, or heroin (Schweinhart et al. 2005). Similar, although not statistically significant, findings for reduced rates of cigarette smoking among program participants were also observed for 21-year-old adults who had participated in the Carolina Abecedarian Project (Campbell et al. 2002). At age 21, Carolina Abecedarian Project

participants were less likely than controls to have smoked marijuana during the past 30 days. No significant differences were observed for binge drinking.

A longer-term evaluation of the IHDP examining the effects of program participation on risk behaviors including conduct problems, suicidal ideation and attempts, smoking, alcohol and marijuana use, and risky sexual behaviors found that risk behavior scores for program participants at age 18 did not differ from those observed for the control group (McCormick et al. 2006a). No differences were found between caregiver and youth self-reported health status for participants relative to the control group. Measures of health considered included self-reported general health status, limitations in activities because of health problems, physical pain, level of vitality/fatigue, and general mental health. The authors did not examine the extent to which the heterogeneity of household socioeconomic status in this sample may have moderated the effects of program participation on health outcomes.

Large-scale publicly-funded programs

Evaluations of the effects of large-scale public programs have examined associations between program participation and several child health outcomes: receipt of immunizations (Currie and Thomas 1995), height-for-age (Currie and Thomas 1995), substantiated reports of child maltreatment (Reynolds and Robertson 2003a), and county-level child mortality among children aged 5-9 from causes potentially addressed by Head Start health services and resources (Ludwig and Miller 2005d).

Race-specific fixed effects models were used to examine the effects of Head Start participation on immunization rates for measles and height-for-age among black and white children (Currie and Thomas 1995). Children who participated in Head Start were compared with two control groups: siblings who did not attend preschool and siblings who attended programs other than Head Start. Black and white children who attended Head Start were more likely to have received a measles immunization than children who were not enrolled in any preschool program. Head Start program participation was not associated with nutrition and health status as measured by height-for-age.

A regression discontinuity design was used to assess the effects of Head Start health on county-level child mortality from outcomes that would plausibly be detected and addressed by the health care resources included as part of Head Start programming: tuberculosis, whooping cough, infections, polio, measles, diabetes, malnutrition,

anemias, and respiratory problems such as asthma, bronchitis, and pneumonia (Ludwig and Miller 2005c). This analysis exploited differential levels of early funding for Head Start to compare child mortality rates for the 300 poorest counties in the U.S., a group that received augmented funding during the early years of Head Start implementation from 1965-1979, with those observed for poor counties immediately above the cut point for augmented funding that received standard levels of Head Start funding. A 50 -100 percent increase in Head Start funding was associated with a 33-75 percent decline in mortality rates for children 5-9 years of age. Their conclusions are supported by findings indicating no significant discontinuities for causes of death unrelated to Head Start health programming and no reductions for other age groups who were not eligible for enrollment in Head Start. These results may offer a conservative estimate for the effects of Head Start programming on relevant child mortality outcomes since the comparison group of counties also received Head Start funding and resources, albeit at lower levels of funding.

An examination of the effects of participation in the Chicago CPC on substantiated reports of child maltreatment found that preschool intervention enrollment at ages 3 or 4 was associated with a 52 percent reduction in the rate of documented child abuse or neglect by age 17 (Reynolds and Robertson 2003b). Participation in the school-age component of the CPC program was not in itself associated with lower rates of child maltreatment. However, a dose-response effect was evident for extended program participation with children enrolled for 4-6 years having lower rates of child maltreatment than those participating for 1-4 years. The effects for preschool program participation on child maltreatment were found to increase over time, with significant reductions in child abuse and neglect for the intervention group only evident after age 9. Parental involvement in school was found to be a significant mediator of intervention effects on child abuse and neglect.

Evidence for Indirect Effects of Early Childhood Programs on Health Outcomes

While few studies have examined direct associations between early childhood programs and physical health outcomes, a number of studies have documented significant associations between such programs and developmental outcomes that, while important in their own right, are also likely contributors to subsequent physical health outcomes: cognitive function, academic achievement, high school completion, educational attainment, employment status, and income. We hypothesize that early childhood programs may indirectly influence health outcomes through their longer-term effects on SES for those most at risk for future adverse health

outcomes. Increasing academic achievement, educational attainment, and subsequent income among children from low SES households may be a policy lever for flattening the socioeconomic gradients in developmental health outcomes.

Model early childhood intervention programs: In this section we review findings for four types of outcomes: cognitive development, educational outcomes, criminal involvement, and economic well-being. Criminal involvement and incarceration are included since incarceration is associated with many adverse health outcomes such as hepatitis C, tuberculosis, and infection with Human Immunodeficiency Virus (HIV) (Johnson and Raphael 2005; MacNeil, Lobato, and Moore 2005; Hammett, Harmon, and Maruschak 1999). A criminal record has also been found to be associated with low wages, unemployment, and family instability (Pager 2003; Western, Kling, and Weiman 2001; Holzer 1996).

Cognitive development. All of the included model early childhood programs reported significantly higher IQ scores for program participants during and immediately after program participation. Significant effects on IQ were sustained longest for children enrolled in the Carolina Abecedarian Project (to age 12) and the IHDP, intensive full-day, full-year programs which both began during infancy (Campbell and Ramey 1995). The IHDP found that only higher low birth weight infants (2,001-2,500 grams) had significantly higher IQ scores than controls by age 8 and at age 18 (McCormick et al. 2006c; McCarton et al. 1997). A significant cognitive advantage for children participating in the Perry Preschool Project relative to controls was sustained till age 7 (Weikart, Bond, and McNeil 1978).

The Carolina Abecedarian Project, based upon a 4-way treatment design, also examined the relative effects of preschool intervention with and without a parent-mediated school-age intervention offered during the first three years of elementary school, participation in only the school-age intervention component, and no participation in either stage of intervention. Preschool participation was associated with significantly higher child IQ scores through age 12 (Campbell and Ramey 1995). Scores for children who received the extended intervention were virtually identical to those for children who received only the preschool component. Participation in the school-age intervention alone was not associated with significant effects on child IQ scores.

These findings suggest that very early intensive interventions having relatively long periods of duration may have larger and longer lasting effects on child cognitive development. The Carolina Abecedarian Project and the

IHDP both provided intensive full-day full-year center-based care and preschool for disadvantaged children for the first 3 to 5 years of life. The small number and nature of model programs that have significantly enhanced long-term child cognitive development do not allow us to disentangle the independent effects of program timing, intensity, duration and modality of treatment on child cognitive functioning.

Educational outcomes. In contrast to the findings for cognitive development, results for longer-term intervention effects on educational outcomes are consistently positive with model program participants having higher achievement test scores, lower rates of grade retention, lower use of special education services and dropout, and higher rates of high school graduation, college enrollment, and overall educational attainment. Rates of high school completion among participants in the Perry Preschool Program were found to differ significantly by sex. While rates for high school completion did not differ for male preschool participants relative to controls, female participants were significantly more likely to have completed high school than women in the control group (Schweinhart et al. 2005). An evaluation of educational outcomes among 18-year-old adults who had participated in the IHDP was unable to assess program effects on educational attainment and high school graduation due to the young age of the sample (McCormick et al. 2006b). However, this study did find that IHDP participants who had been higher low birth weight infants had significantly higher verbal and math achievement scores than controls.

While the Carolina Abecedarian Project did not find significant differences for high school graduation, preschool participants had higher reading and math scores and were more likely to have enrolled in college by age 21 (Campbell et al. 2002). The authors note that the exceptionally high quality of the local school system subsequently attended by all program participants and controls may have closed some of the academic gaps between treatment and control groups (Campbell and Ramey 1995). Participation in the school-age component did not, in the absence of preschool participation, lead to significantly higher academic achievement. While those who participated in both the preschool and school-age components had higher reading scores, participation in the extended intervention did not lead to significant increases in math scores or IQ (Campbell and Ramey 1995). Participation in the preschool component conferred the largest and most sustained effects on cognitive and academic outcomes.

Criminal involvement The two studies that have examined associations between early childhood program participation and adult criminal involvement and incarceration present ostensibly contradictory findings. Former participants in the Perry Preschool Project had significantly lower rates for being arrested or imprisoned from ages 19 through 40 (Berrueta-Clement et al. 1984; Schweinhart, Barnes, and Weikart 1993; Schweinhart et al. 2005). Treatment effects were especially marked for male program participants (Schweinhart et al. 2005). In contrast, the Carolina Abecedarian Project found no significant differences between preschool participants and controls at age 21 with respect to types of crimes committed, age of first arrest, or numbers of charges by type of offense (Clarke and Campbell 1998). These findings indicate that significant increases in cognitive functioning and educational outcomes, as noted among the Carolina Abecedarian project participants, did not necessarily lead to reductions in crime and delinquency.

The authors examined differences between the Perry Preschool Project and the Carolina Abecedarian Project in light of these divergent intervention effects and questioned whether parental program involvement during the preschool years, a notable difference between the two interventions, may have mediated the Perry Preschool Project's significant and enduring effects on subsequent criminal involvement. Indeed, early childhood programs that have successfully led to future reductions in crime, delinquency, and school misbehavior have all combined early childhood education with intensive family support including home visits and family counseling (Clarke and Campbell 1998; Yoshikawa 1995).

Economic well-being. The Perry Preschool Project is the only model program to have examined the effects of program participation on longer-term adult economic wellbeing. Program participants were significantly more likely to be employed, to own a car, to own their own home and to have higher median earnings at ages 27 and 40 than controls. Long-term follow-up analyses for participants at ages 19, 27, and 40 indicate that significant economic advantages have persisted and, in some instances, increased through adulthood (Schweinhart et al. 2005; Schweinhart, Barnes, and Weikart 1993; Berrueta-Clement et al. 1984). For example, the difference between median annual earnings for program participants and controls increased from \$2,000 at age 27 to \$5,500 at age 40. At age 40, 60 percent of the program participants had annual incomes over \$20,000 per year as compared with 40 percent of the control group (Schweinhart et al. 2005).

Large-scale publicly funded early childhood programs: In this section, we review evidence for the effects of the Chicago CPCs and Head Start on educational outcomes, criminal involvement, and economic well-being. Measures of academic skills and achievement have typically been used as proxy measures of cognitive functioning.

Educational outcomes Evaluations of the effects of the Chicago CPC on educational outcomes have found that preschool participation was significantly associated with higher achievement test scores, a lower rate of high school drop out, a higher rate of high school completion by age 20, and more years of completed education (Reynolds et al. 2001a). The effects of preschool participation on rates of high school dropout were found to differ by sex. Adjusted rates of school dropout were significantly lower for male preschool participants relative to controls but not for females. Program participation was also associated with higher rates of high school completion by age 20 for males but not for females. These findings are notable in light of high rates of school failure and dropout among black males in the US.

In contrast, participation in only the school-age CPC component was not associated with high school graduation, dropout, or educational attainment relative to the school-age comparison group after controlling for preschool participation and other model covariates. However, participation in the school-age component for at least one year was associated with lower rates of special education and grade retention after controlling for preschool status (Reynolds et al. 2001b). Those who participated in the extended intervention had the lowest rates for use of special education services and grade retention. An analysis of the effects of CPC preschool participation and full duration of program participation indicated that both preschool participation and years of total participation were associated with school achievement and risk for grade retention (Reynolds 2000). A dose-response effect was noted for the effects of extended intervention on achievement and dropout (Temple, Reynolds, and Miedel 2000).

Confirmatory program evaluations have been used to assess the roles of several hypothesized mechanisms and causal pathways in mediating the effects of the Chicago CPC preschool participation on high school completion (Reynolds 2004; Reynolds, Ou, and Topitzes 2004f; Miedel and Reynolds 1999; Reynolds et al. 1996). The school support hypothesis postulates that the effects of early childhood intervention are sustained to the extent that children subsequently attend schools of sufficient quality to maintain or enhance the effects of program

participation. Measured by post-program magnet school attendance and school mobility, the school support hypothesis explained the largest percentage (31 percent) of the indirect effects of CPC preschool participation on high school completion (Reynolds, Ou, and Topitzes 2004e). The school support hypothesis, especially magnet school attendance, explained more of the association between CPC participation and high school completion than several other hypothesized pathways: family support (extent to which program participation enhances parents' abilities to support child development: 28 percent), cognitive advantages (improvements in children's abilities: 23 percent), motivational advantages (changes in participants motivational development: 1.7 percent), and social adjustment (improved social adjustments and self-regulation: 0.8 percent) (Reynolds 2004).

Examinations of the effects of Head Start on reading vocabulary and grade repetition for Hispanic (Currie and Thomas 1999), and white and African American children (Currie and Thomas 1995) have used sibling fixed effects models to compare outcomes for Head Start participants with those with for siblings who did not attend preschool or who attended a preschool program other than Head Start. Statistically significant and positive effects of Head Start on subsequent achievement test scores were initially found only for white (Currie and Thomas 1995) and Hispanic Head Start participants (Currie and Thomas 1999). However, the addition of a program by age interaction term to the model revealed that Head Start participation had significant and initially equal direct effects on test scores for black and white children (Currie and Thomas 1995). A significant program by age interaction for black children indicated that Head Start effects on achievement scores for black children "faded out" by age 10 while white children retained 71 percent of their initial gains. Measures for home and family environment did not moderate retention of Head Start effects among black children. Among white children, Head Start participation was also associated with reduced grade repetition (Currie and Thomas 1995).

These findings parallel earlier results from earlier studies of Head Start (Lee et al. 1990; Lee, Schnur, and Brooks-Gunn 1988). The effects of Head Start participation on measures of cognitive function were examined using control groups composed of children from the same neighborhoods who were eligible for Head Start but did not attend preschool or attended another preschool program. The Head Start participants, especially black children, had significantly larger increases for measures of cognitive function after controlling for substantial differences in initial cognitive and socioeconomic factors between the two groups (Lee, Schnur, and Brooks-Gunn 1988). Yet despite these substantial gains, Head Start participants still had absolute measures of cognitive

function that were significantly lower than those found for either control group following program completion. A subsequent analysis based on the sub-sample of black children found that Head Start effects on cognitive ability were sustained but diminished following completion of first grade (Lee et al. 1990).

Two studies have examined potential explanations for the gradual fadeout of the effects of Head Start on cognitive and achievement outcomes among black children (Currie and Thomas 2000; Lee and Loeb 1995). Head Start participants were found to subsequently attend middle schools that had lower average student SES, lower average academic achievement, and lower overall academic quality and safety (Lee and Loeb 1995). The same data was later used to examine potential racial differences in the quality of middle schools subsequently attended by black and white Head Start participants (Currie and Thomas 2000). Black children who had participated in Head Start were, unlike white Head Start participants, systematically more likely to attend poorer quality middle schools than other black children. Black Head Start children attended middle schools having low average achievement test scores and low levels of variance across children. White Head Start children were found to attend average quality schools that did not differ from those attended by the average white student.

Two studies have examined associations between Head Start participation and high school graduation and college enrollment at the individual (Garces, Thomas, and Currie 2002) and county levels (Ludwig and Miller 2005b). An analysis based on sibling fixed-effect models found that while whites who had attended Head Start as children were more likely to complete high school and to attend college than siblings who did not attend Head Start or attended other preschools, there were no significant effects for black program participants. Differences by gender were also observed: black and white males were more likely to complete high school than female participants (Garces, Thomas, and Currie 2002).

A regression discontinuity design was used to examine the effects of differential levels of Head Start funding on county-level measures of adult educational attainment (Ludwig and Miller 2005a). Evidence of positive discontinuities for county-level rates of high school completion and college attendance was found at the federal cutoff for county eligibility for augmented early Head Start funding. Increases in high school completion and college attendance were concentrated exclusively among cohorts born late enough to have been exposed to the Head Start program. No discontinuities were noted for college graduation. However, such a result is not

unexpected given the relatively young age of the Head Start cohort in 1988-1990, the years of outcome ascertainment.

Criminal involvement Two studies have examined associations between participation in large-scale childhood interventions and future delinquency and crime involvement (Reynolds, Ou, and Topitzes 2004d; Garces, Thomas, and Currie 2002; Reynolds et al. 2001c). Participation in the preschool component of the CPC program was associated with significantly lower rates and numbers of juvenile arrests for both violent and nonviolent crimes by age 18 (Reynolds et al. 2001d). In contrast, participation in only the school-aged component of the CPC program was not associated with reduced rates of arrest or with any other measure of delinquency or crime. Extended program participation through 3rd grade did not confer additional benefit with respect to further reductions in risk for juvenile delinquency by age 18. A series of confirmatory analyses were later conducted to assess potential mediators of the effects of CPC preschool participation on juvenile arrest. The two strongest mediators of the effects of preschool CPC participation on court-reported juvenile arrest by age 18 were subsequent enrollment in a magnet school and parental involvement in school (Reynolds, Ou, and Topitzes 2004c).

Fixed-effects models have been used to compare rates of ever having been booked for or charged with crime for Head Start participants with siblings who did not attend the program. Blacks who were enrolled in Head Start as children were significantly less likely to have been booked for or charged with a crime (Garces, Thomas, and Currie 2002). There were no significant effects on criminal involvement for white program participants relative to their siblings.

Economic outcomes Only one study has thus far examined the effects of a large-scale program on adult earnings (Garces, Thomas, and Currie 2002). Little evidence was found for significant effects of Head Start participation on earnings among adults aged 23-25 who were employed. However, the earnings advantages associated with higher rates of high school completion and college attendance may only emerge as program participants continue on in their work life and employment trajectory.

Summary

While the differing sample and program characteristics of the early childhood programs reviewed here make it difficult to generalize with certainty, the evidence suggests that early childhood programs have significant and

sustained direct and indirect effects on health and well-being through childhood and into adulthood. Evidence for long-term intervention effects on academic achievement and educational attainment is especially consistent and robust. Participation in early childhood programs can lead to sustained increases in adult SES.

Several themes and questions for future research arise from this review of the literature. First, evidence suggests that earlier interventions may be more effective than those offered during the primary school years. Second, comprehensive programs that address multiple risk factors by combining early childhood education with family support services and health and nutrition resources may more effectively address multiple dimensions of child and adult well-being. Third, the quality of school attended post-program may mediate and/or moderate the effects of early childhood programs on developmental health outcomes through childhood and into adulthood.

Earlier interventions may be most effective The two projects that had the strongest and most enduring effects on child cognitive functioning all enrolled participants during infancy and offered highly intensive, center-based preschool interventions that lasted from 3-5 years. The different sampling characteristics of these studies, with study eligibility defined by low SES (Carolina Abecedarian) and low birth weight and pre-maturity (IHDP), limit our ability to compare intervention effects across samples. The Perry Preschool Project, which enrolled participants in intensive center-based preschool at 3 years of age, did not find statistically significant improvements in child cognitive performance for program participants after age 7.

However, evidence from the Carolina Abecedarian and Perry Preschool projects indicates that preschool participation can have long-term effects on academic achievement and educational attainment even in the absence of sustained significant effects on cognitive functioning. This may represent a classic pathway effect as described above: the improvement of general cognitive function places the child on a different trajectory, for which there are greater opportunities for building on educational input. Educational attainment is especially salient given its strong patterns of association with income, occupational status, and health behaviors and with adult health behaviors and outcomes. Although effects were not always statistically significant, participants in all of the model preschool interventions and the Chicago CPC all had lower rates of grade retention, use of special education and dropout and higher rates of high school completion than their respective comparison groups. While evidence for the long-term effects of Head Start is still limited, program participation may be associated with higher rates of high school graduation and college attendance, especially among white participants. These findings collectively

suggest that interventions that begin in preschool or infancy can effectively increase the educational achievement and attainment of socio-economically disadvantaged and at-risk children.

Two of these studies, the Carolina Abecedarian Project and the Chicago CPC, also examined the relative efficacy of preschool programs versus interventions offered only during the early grades of elementary school. Both found that interventions offered only during the early elementary school years did not in and of themselves have significant effects on longer-term academic performance or educational attainment. While the school-age intervention did significantly reduce use of remedial services and grade retention among Chicago CPC participants, it did not have significant effects on high school dropout, graduation rates, juvenile delinquency, or educational attainment (Reynolds et al. 2001e). Preschool participation was found to have the largest and most persistent effects on child and adult outcomes (Campbell and Ramey 1995; Campbell and Ramey 1995; Reynolds et al. 2001f).

Comprehensive programs that address multiple dimensions of child and adult well-being The most successful interventions have simultaneously addressed multiple dimensions of child well-being: cognitive and social development, health and nutrition, and familial relationships and parenting skills. The Perry Preschool and Carolina Abecedarian projects, the IHDP, and the Chicago CPCs all included nutritional and health resources. The Perry Preschool Project and the Chicago CPC also involved parents through home visits, counseling, and school involvement.

While few studies have evaluated the relative contributions of differing program components, evidence from the Chicago CPC indicates that parental involvement in school activities and in encouraging child learning and development is an especially strong mediator of the effects of preschool participation on reading achievement, grade retention, special education placement, substantiated cases of child abuse and neglect, high school completion and juvenile arrest (Reynolds 2004; Reynolds, Ou, and Topitzes 2004b; Reynolds and Robertson 2003c; Miedel and Reynolds 1999). These findings underscore the importance of parenting support in mediating the effects of early childhood programs and illustrate the importance of assessing potential pathways and mechanisms for intervention effects on child well-being.

Quality of post-program school may mediate and/or moderate the effects of early intervention Evidence from both of the large-scale, multi-site public programs considered in this chapter suggests that the quality of

post-program school may mediate or moderate the effects of early childhood interventions on subsequent child and adult outcomes. Subsequent post-program magnet school attendance mediated the largest proportions of the indirect effects of Chicago CPC preschool participation on high school completion and court-reported juvenile arrest by age 18 (Reynolds 2004; Reynolds, Ou, and Topitzes 2004a). Indeed, subsequent magnet school attendance mediated more of the effects of Chicago CPC intervention on these outcomes than measures of family support, and cognitive, motivational, social adjustment gains arising from program participation.

Evidence from studies of the effects of Head Start suggests that post-program school quality may moderate the persistence of program effects on subsequent academic achievement (Currie and Thomas 2000; Lee and Loeb 1995). While these studies were unable to explicitly test this hypothesis because of data limitations, racial differences in the quality of post-program schools offer a potential explanation for the differential persistence of Head Start effects on academic achievement and performance outcomes among black and white children.

These findings highlight the importance of examining the effects of early childhood programs within the broader context of local, state, and national educational policy. The longer-term effects of early childhood programs may depend upon the extent to which subsequent school experiences sustain and build upon the benefits of early intervention. Early childhood programs cannot in and of themselves “inoculate” or fully protect children from the ongoing effects of socioeconomic disadvantage. These findings reflect the effects of cumulative risk or protection: children tend to spend their formative years in similar environments across time. A policy implication is that, despite the demonstrated importance of early childhood to subsequent developmental health, there are unlikely to be “magic bullets” that solve problems of population developmental health through early childhood programs alone.

This review also underscores the need to consider the effects of model early childhood programs within the context of their geographically and historically specific educational policies and resources. For example, all of the children participating in the Carolina Abecedarian Project (98 percent black), conducted in a university town, subsequently attended schools in a district where 14 percent of the students were black and 80 percent were white. The investigators note that “efforts were made by all principals to obtain a fair and representative balance of ethnic and socioeconomic levels in all classrooms” (Campbell and Ramey 1995). The racial and probable socioeconomic composition of the schools that the Carolina Abecedarian Project participants attended contrasts

sharply with that attended by the average black student in the U.S. in 2002-03: a school having a student body that was 54 percent black and 30 percent white where 49 percent of the students were poor (Orfield and Lee 2005). In 2002-03, the average white student attended a school where 78 percent of the students were white, 9 percent were black, and 23 percent of the students were poor.

Future research may need to explicitly examine the extent to which local primary and secondary school composition, resources, and policies may mediate and/or moderate the effects of early childhood interventions on child and adult developmental health outcomes. Early childhood programs have thus far been structured and examined as independent entities without regard to the broader societal context within which they are embedded. Family, neighborhood, community, and school factors may all likely shape the short- and longer-term effects of early childhood interventions on child, adolescent, and adult well-being.

Childhood Programs within the Context of National Education and Human Development Policies

The longer-term effects of early childhood programs on socioeconomic attainment and developmental health outcomes may be conditional upon the national- and state-level policies that influence the financing, quality, and social composition of primary and secondary schools. One potentially salient feature of educational and human development policies in the U.S. is decentralized state and local funding of public services and goods such as education, public welfare, and police and corrections. Distributional systems that govern the funding and allocation of public goods are examples of human development policies that may have enduring effects on community resources and developmental health outcomes among children and adults. The U.S. is rare among industrialized nations in its heavy reliance upon local property taxes for the funding of public goods and services, a financing system that may lead to large disparities in levels of funding for education and resources across communities having different tax bases.

Theoretical models from the fields of economics and public finance contrasting the potential short- and long-term effects of decentralized (local) and centralized (state or national) funding of public education offer a framework for considering the effects of finance policies on educational outcomes and subsequent health outcomes (Benabou 2000; Benabou 1996a; Benabou 1996b; Durlauf 1996; Tiebout 1956). Decentralized funding based on property taxes may induce economic segregation and stratification as lower-income families are unable or unwilling to pay higher taxes to fund school and other public services. The resulting stratification may lead to

persistent inequality in education and income earnings across generations since the educational achievement and attainment of each successive generation is contingent upon local social and financial resources (Benabou 1996b).

Persistent inequality and “poverty traps” may arise when poor families become completely isolated from the rest of the economy, leaving poor children structurally unable to accrue sufficient human capital through either educational opportunities or through exposure to role models and mentors (Durlauf 1996). The absence of shared education or social interactions leads to separate and independent trajectories and equilibria for poor and wealthy families segregated in different neighborhoods. Residential segregation effectively determine the material and social environment, educational and employment opportunities, and subsequent socioeconomic status for low income and minority populations and function as a central mechanism for creating and sustaining racial and socioeconomic health inequalities in the United States (Acevedo-Garcia and Lochner 2003; Williams and Collins 2001). The education finance system in the U.S. may have a substantial role in generating and sustaining the socioeconomic and racial segregation and concentrated disadvantage that early childhood education programs are designed to address.

Empirical evidence indicates that state and local investments in public goods are associated with child and adult well-being (Dunn James R., Burgess, and Ross 2005; Harknett et al. 2005) . After adjustment for state variation in the cost of providing services, states having greater total per capita expenditures and higher per capita spending on education, environment and housing, public welfare, and police and corrections relative to the U.S. average had significantly lower mortality rates (Dunn James R., Burgess, and Ross 2005). Public expenditures on education were found to have the largest and most significant effects on state mortality rates.

While state-level expenditures for education vary, a number of studies have documented increasing equalization of school expenditures across districts within states in response to legal cases challenging the constitutionality of local funding of public schools (Corcoran Sean et al. 2003; Murray, Evans, and Schwab 1998). However, these ostensible equalized district-level educational expenditures have not accounted for the differential costs of providing school inputs across districts or the differing needs of disabled students, children from low income families, and children for whom English is a second language (Wilson, Lambright, and Smeeding 2004; Rubenstein 2002). While unadjusted educational expenditures and those adjusted for the differential costs of providing educational inputs were found to be largely equal across districts, adjustment for

the additional costs of effectively addressing student needs revealed large racial inequalities across the entire income distribution, with black and Hispanic students having lower levels of adjusted educational expenditures than white students of comparable income across all levels of family income (Wilson, Lambright, and Smeeding 2004). Differences in local revenue accounted for differential levels of adjusted educational expenditures across socioeconomic and racial/ethnic groups. Thus, equal educational expenditures do not adequately offset inequalities arising from residential segregation and a decentralized system of educational finance based upon revenue from local property taxes.

Economic segregation may have significant effects on educational achievement and attainment and on socioeconomic gradients in educational outcomes (OECD 2004; Willms 2004; Mayer 2002). An examination of the effects of changes in economic segregation in the U.S. between 1979 and 1990 between and within census tracts within the same state on overall educational attainment and on educational attainment for students from low and high income households found that an increase in economic segregation between census tracts increased the gap in educational attainment between high- and low-income students by increasing educational attainment among high-income children and reducing educational attainment among low-income children. These effects were found to offset one another and lead to no net change in overall levels of state educational attainment. Thus, policies which contribute to the emergence and persistence of increasingly segregated and economically homogeneous communities may lead to increased disparities in educational attainment across measures of parental SES. Given the robust evidence of associations between educational attainment and health, such policies would also be expected to maintain or increase the slope of socioeconomic gradients in health outcomes by reducing the intergenerational mobility and socioeconomic achievement of children from households having lower levels of SES.

The need to consider a broad range of human development policies This review has focused upon early childhood programs, and to some extent on primary and secondary schools, and the finance system underlying the distribution of public goods in the U.S., as examples of human development policies that influence individual health, socioeconomic gradients, and population health. It is essential to also consider the full range of policies that may have profound, albeit often unintended, effects on health across the life course. As one example, maternal and parental leave policies may have significant and enduring effects on health beginning in utero and

extending through the life course (Tanaka 2005; Berger, Hill, and Waldfogel 2005; Ruhm 2000). The United States, with no national mandated job-protected paid leave, had the shortest period of leave (12 weeks of unpaid leave), among the 18 OECD countries included in one cross-country study based on data from 1969-2000 (Tanaka 2005). In contrast, the range of weeks of job-protected paid leave for all other countries included in the study ranged from 14 (Germany, Ireland, and Japan) to 68 weeks (Sweden).

Weeks of job-protected paid leave was associated with significant reductions in rates of low birth weight, and infant, post-neonatal, and child mortality (Tanaka 2005). Weeks of unpaid leave and non-job protected leave, the only option available to many families in the U.S., did not have significant effects on any of the child health outcomes considered. Additional evidence from the U.S. indicates that mother's return to work within the first 12 weeks of giving birth was associated with increases in externalizing behavior among children and with reductions in child immunizations and in the initiation and duration of breastfeeding, with effects being generally stronger for women who returned to work full-time (Berger, Hill, and Waldfogel 2005; Chatterji and Frick 2003). Similarly, a national level longitudinal U.S. sample found significant negative effects on social behavior of early-beginning, high-quantity child care (NICHD Early Child Care Research Network, 2006). While these studies do not examine potential interactions by race or socioeconomic position, studies of breastfeeding have noted that rates of initiation are lowest among black mothers, unmarried mothers, and among those having lower levels of income and educational attainment (Li et al. 2005). Breastfeeding is associated with significantly lower blood pressure (Martin, Gunnell, and Davey Smith 2005), reduced risk for adult overweight (Harder et al. 2005), and increased cognitive ability (Evenhouse and Reilly 2005). These findings suggest that the enactment of a universally available policy of paid job-protected maternal leave in the U.S. could have potentially profound effects on a range of child health outcomes, racial and socioeconomic health disparities, socioeconomic gradients, and overall levels of population health in the United States.

Another example of a broad policy intervention is that of PROGRESA, a multifaceted program with the mothers of preschool and school-age children in Mexico, begun in 1997. The core of this intervention was to provide cash transfers to mothers of poor children contingent upon their participation in the program, which included regular health visits during preschool, ensuring child's attendance at school, attending regular meetings at which health and nutrition issues were discussed, receiving nutritional supplements for the child, and regular

monitoring of child growth. In this sense, there are both health and human development components to this policy intervention. A number of program evaluations have shown direct health effects, including increased growth and reduced stunting (Behrman & Hoddinot, 2005) and indirect effects, including decreased rates of repeating grades or dropping out, and increased rates of returning to school after early leaving (Behrman, Sengupta, & Todd, 2005). Whether comparable effects could be obtained in the U.S. or similarly economically advantaged jurisdictions is uncertain, given that core nutritional needs are less implicated (Fogel, 2003) and that school attendance during the main impact years in PROGRESSA may have ceiling effects. Adaptation of this approach, contingent cash transfers to mothers for investment in child health and development, including the health education and monitoring components used by PROGRESA and perhaps adding participation in early child development and education programs as a new component, is a policy experiment potentially worthy of investigation. Whether such a model is politically feasible in the U.S. or elsewhere, however, remains unclear.

A Human Development Agenda for Health

In this overview of the impact of human development policies on health, we have sought to describe a conceptual framework within which to view the impact of such policies on health, including direct and indirect effects, and to review an interdisciplinary range of evidence arising from such a framework. The evidence supports the view that these policies, individually and in the aggregate, are significant contributors to outcomes of developmental health. A coordinated research and policy agenda may be needed to begin to better understand relationships between human development policies and developmental health across the life course. On the research side, interdisciplinary investigations that identify the pathways from social disparities in circumstances to disparities in outcomes, including the underlying developmental mechanisms, represents an important scientific program. On the policy side, understanding the connections among human development and health policies would provide substantial leverage to improve childhood circumstances, and consequently, population health. The political will to enact such reforms may be strengthened by a deeper understanding in the public at large of the depth, strength, and health implications of prevailing policies and practices that affect human development.

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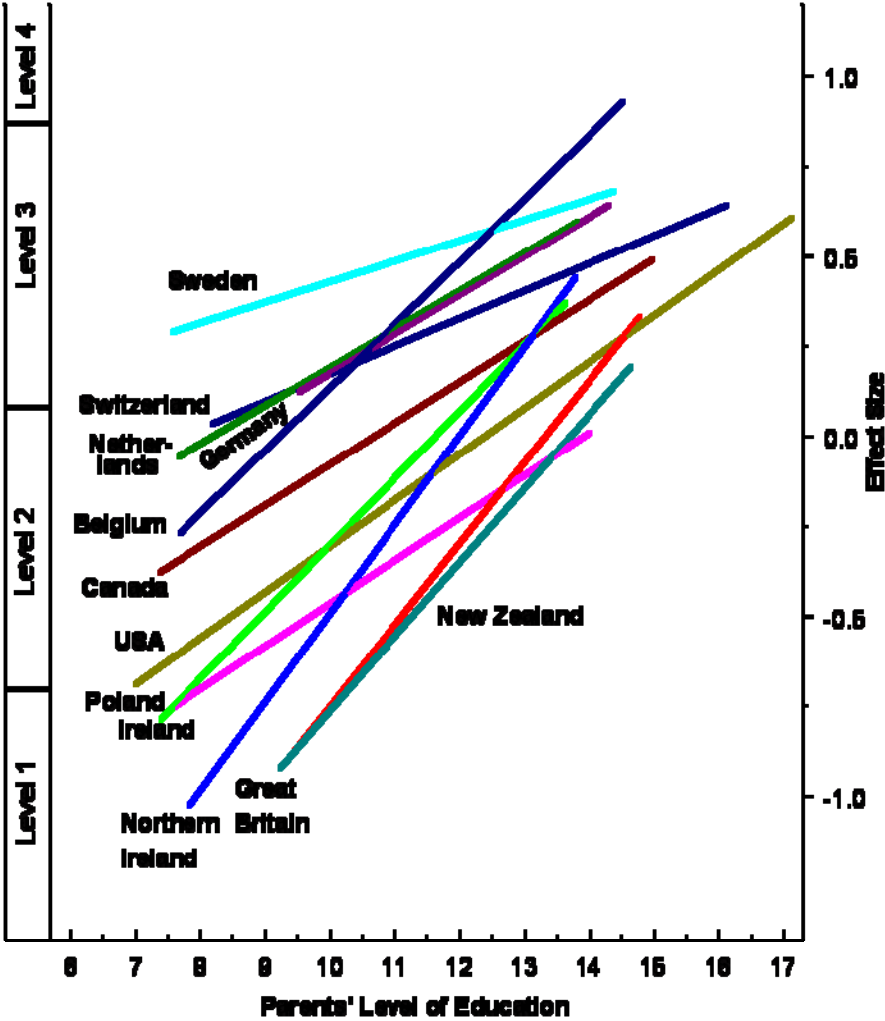
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Figure 1 Caption

Adapted and updated from Willms (1999a, Figure 5.1)



**Figure 1-2. Quantitative Literacy Scores for Youth Aged 16-25
International Adult Literacy Study, 1994**