

# How socio-economic disadvantage modifies health outcomes in children with cerebral palsy

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Cerebral palsy (CP) is the most common cause of childhood physical disability. While its etiology has long been thought to involve perinatal adversity, knowledge of causal pathways has evolved to include prenatal biological risk factors such as congenital malformations, infections, and genomics. New evidence casts light on this heterogeneous condition as a modifiable phenotype. Social disadvantage not only increases the risk of CP but also modifies its severity and progression.<sup>1</sup> Identifying modifiable risk factors that lead similarly affected infants to have distinct childhood outcomes offers some hope of early intervention.

In the largest study to date, Woolfenden et al.<sup>2</sup> utilize data from the Australian Cerebral Palsy Register to investigate social disadvantage on CP severity. The authors found that socio-economic status (SES) at birth predicted CP severity at age 5 years. More specifically, they observed a positive linear trend between neighborhood SES and CP severity as measured by mobility, cognitive function, and comorbidities. An increased risk of the most severe indicators of CP was observed independent of gestational age. Both young motherhood (<20y) and ethnic minority status – measures of individual level SES – were also associated with a higher risk of CP severity. However, applying mediation methods, the authors show no additional direct effect of SES on CP severity among younger and/or minority mothers. Conversely, among non-minority mothers 20 years or older, the authors reported a strong direct effect of SES on CP severity. In other words, a socio-economically disadvantaged neighborhood was independently associated with a higher risk of a child being non-ambulatory, having at least moderate intellectual impairment, and severe comorbidities at age 5 years. This evidence suggests that CP is a modifiable phenotype by social disadvantage. Individual level SES factors

were based solely on maternal age and ethnicity and did not include parental education or occupation. Neighborhood level SES was based on indexes using data from the Australian Bureau of Statistics and included education, income, and employment. Although intranational disparities exist even among high-resource settings, the study findings are concordant with reports from other settings.<sup>1</sup>

The association between social disadvantage and child health is well established across pediatric populations. Several mechanisms have been proposed to understand the social and biological impact of SES in childhood. Cumulative effects of adversity across the life course include cascading consequences of preconception and prenatal exposures (such as material deprivation, poor nutrition, and substance use) on later child outcomes.<sup>3</sup> Emerging evidence suggests that social deprivation can have multigenerational effects, becoming biologically embedded through epigenetic mechanisms such as DNA methylation, by dysregulating the hypothalamic-pituitary-adrenal axis, or through exposure to unmeasured teratogens that impact embryonic development.<sup>4</sup> Furthermore, children with CP are at increased risk of social exclusion in education and community participation, with reduced access to green spaces, leisure activity, and early childhood education, compounded by family coping, motivation, and environmental resources and supports.<sup>5</sup> Social deprivation also impacts parental stress, mental health, and reduces family disposable income available for activities that can further stimulate child development.

A better understanding of resilience in CP is needed: two children exposed to the same risk factors have unique outcomes and yet there is little understanding of what imparts individual resilience. This resilience can be partially explained by inherent factors such as self-efficacy and motivation mastery but also by environmental factors (both familial and community-wide) to which a child is exposed. At the very least, children with CP should be given the same opportunities as typically developing children to grow and develop. Understanding and addressing potential inequalities in distribution of health should be prioritized, especially within a vulnerable population such as children with developmental disabilities.

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