Gene Expression and Social Interaction: Examining the Interplay between Socioeconomic Status, Stress, and Epigenetics

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Experiences in early life can have a dramatic impact on the health of an individual later in life.[1] Several diseases including diabetes, obesity, cardiovascular disease and depression have been shown to have determinants in early childhood.[1] However, it is only recently that scientists have started to investigate how social factors can biologically predispose us to these diseases.

Dr. Clyde Hertzman, a professor at the UBC School of Population and Public Health and Director of the Human Early Learning Partnership, is on the forefront of this research. Dr. Hertzman explains, "I got interested early in my career in the social determinants of health. Over time this led me to the early years and early development being a really important time for generalized vulnerability or resilience to emerge."

Dr. Hertzman and his colleagues see epigenetics as a mechanism by which early experience can directly impact the biological development of an individual. A recent international study conducted by this team seems to support this hypothesis.[2]

In this study, the DNA methylation profile of 109 fifteen–year–old adolescents was determined and then related to parental stress levels at the time these individuals were infants.[2] Measures of stress were recorded multiple times during childhood using several scales. These scales measured various components of stress including depression symptoms, parenting stress, and financial stress. The results showed that children of parents who reported experiencing high stress levels had different epigenetic profiles than children who experienced less familial stress. Several genes, including those affecting anxiety levels and brain development, were shown to exhibit different levels of epigenetic modifications. For example, the gene NEUROG1, which codes for a transcription factor involved in the differentiation of neurons in the developing nervous system, was shown to have increased levels of methylation in its regulatory region in children exposed to higher stress environments, compared to those less exposed.

In another study, Dr. Hertzman and his colleagues were able to illustrate a strong and permanent association between early–life socio–economic position and DNA methylation patterns of subjects.[3] The results indicated that individuals from a disadvantaged socio-economic position in childhood had differentially methylated promoters of genes associated with key cell signalling pathways, as compared to subjects who were in a high socio–economic position as children.

The differential methylation profiles of the studied individuals may suggest that epigenetics is a potential mechanism for environmental factors (e.g. lower socio–economic position in childhood) to affect disease predisposition, and possibly even mortality and morbidity later in life.[3,4] These findings further support the results from the parental-stress study suggesting that early–childhood experiences can have a tremendous impact on an individual's gene expression.[2]

When asked about the potential clinical relevance of these results, Dr. Hertzman does acknowledge that if a relationship exists between early-life social interactions, epigenetics, and disease predisposition, there could be profound clinical implications on disease management. However, what Dr. Hertzman wants the medical world to learn from these studies is that children are not born hardwired and that the social environment one is exposed to early in life plays a critical role in determining health outcomes later in life. The basis of Dr. Hertzman's approach to how this research could be applied clinically is explained is this excerpt:

The clinical application of our approach is to change the mindset of clinicians that deal with families of young children. People carry causal and explanatory models around in their head, the idea that, in effect, the child is born and their personality and temperament will reveal itself. Well what our work is suggesting is that there is more plasticity than that, and that the blueprint is way more malleable than that.

Indeed, Dr. Hertzman hopes these findings will encourage physicians to educate families on the importance of creating safe and nurturing environments that allow children to thrive both mentally and physically.

When asked what the next steps should be, Dr. Hertzman explains that it is important to conduct additional studies aimed at revealing other relationships between social environment and epigenetic modifications before attempting to link these epigenetic findings to specific disease predispositions.

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Hip Fractures: Not Just Another Broken Bone

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In 1997, a study published in the Canadian Medical Association Journal projected the number of hip fractures to increase four–fold over 40 years, which highlighted the need for preventative strategies.[1] Hip fractures place a significant burden on Canadians because of the associated costs of care, pain, morbidity and mortality.[2] In the elderly, the one–year mortality rate after a hip fracture is up to 30%.[3] Furthermore, approximately 50% of hip fracture patients are unable to live independently again—many being unable to walk, dress or bathe.[4] Patients who recover can take up to a year to regain mobility and strength.[5] From a population health perspective, the cost of a hip fracture has been estimated at $18,000 per event, with additional increased costs from loss of independence and need for long term care.[6] Hip fractures have a serious impact at both the population and individual levels, and therefore strategies must be implemented to prevent them.

In contrast to the predicted catastrophic rise in hip fracture rates, a 2011 study published by UBC researchers in Osteoporosis International reported that age–standardized rates in British Columbia actually decreased by 18% between 1990 and 2004.[7] The senior author, Dr. Pierre Guy—associate professor at the UBC department of Orthopedics and researcher at the Centre for Hip Health and Mobility—explains that "the reason for the declining rate is unknown. It may be associated with fall prevention strategies, improved health of the later portion of the cohort or even medications over the observation period."[6] Dr. Guy further explains that:

Prevention of hip fractures can be organized into two general categories of either preventing falls or maintaining/increasing bone strength. The former category includes balance improving exercises, wearing protective hip pads, ensuring a safe home environment, limiting polypharmacy (mainly psychotropic drugs), and the proper assessment and correction of vision. The latter category includes adequate intake of vitamin D and calcium, performing load-bearing exercises, and possibly taking Bisphosphonates.[6]

Dr. Guy also points out the unique interventions taking place in British Columbia, such as Osteofit, an exercise and education program based on published research for individuals at risk of falls. Osteofit is available in over 60 community centers throughout British Columbia. Dr. Guy also mentions other innovative prevention research programs taking place at the Center for Hip Health and Mobility including the Bone Health Research group (BHRG), the Centre of Excellence on Mobility, Fall Prevention and Injury in Aging (CEMFIA), Technology for Injury Prevention in Seniors (TIPS), and the Falls Prevention Clinic.[6]

The decreased rate of hip fractures may reflect positive steps taken towards prevention. It is important to note however, that despite this decrease, the absolute number of hip fractures continues to rise due to the growing population, particularly in the expanding fraction of the elderly. In British Columbia this year, over 3,500 people will suffer a hip fracture that will further affect the lives of their family and friends.[8] By vigorously promoting prevention in patients of all ages, healthcare providers in British Columbia can help reduce the number of people affected by this incapacitating and deadly injury.

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