

occur following exercise are reviewed by Ntanasis-Stathopoulos, J, *et. al.*¹ Exercise-induced changes impact genetic expression in everything from adipose tissue, skeletal muscle, and the cardiovascular system, to changes in the neuronal signaling in the brain. Another example of environmental influences on genetic expression is in diet. Much like the epigenetic changes induced by exercise, the choices we make in regard to what and how much we eat as well as environmental conditions (famine, malnutrition, microbiome) drive epigenetic changes that can be long lasting. Many facets of health including susceptibility to chronic illness and obesity are impacted by dietary epigenetics which prompted McKay and Mathers to develop the concept of the four “Rs” which refer to the process by which diet drives these epigenetic changes. In their conceptual model of the four “Rs”, “nutritional and other exposures are **R**eceived and **R**ecorded by the genome, evidence of these exposures is **R**emembered across successive cell generations and the consequences of these exposures are **R**evealed as altered gene expression, cell function and, ultimately, health”^{2,3}

The point is that, yes, we can be dealt a bad hand of genetic cards. We can be born with genetic risk factors for hypercholesterolemia (*APOB*, *LDLR*, *LDLRAP1*, and *PCSK9*), diabetes (it is known to be genetically inherited, however the genetic risk factors are complex and have yet to be concretely identified), and breast cancer (*BRCA1* and *BRCA2*) to name a few. But the fact is, for virtually all diseases, two factors need to come to play, both an inherited predisposition and an environmental trigger. This is the case for cancer, diabetes, heart disease, and we have to assume for myriad other diseases. We have to assume that this is the case when it comes to diseases and dysfunctions of the brain.

People say that you can't stop violence because that is just human nature. However, as thinking, planning, scenario contemplating people, we can decide to take specific actions that are contrary to the typical evolutionary pressures that drive other species. We **can** imagine doing things differently. We **can** imagine a healthier future for ourselves and then take action by modifying our diet, initiating an exercise program, or refraining from unhealthy or risky activities such as smoking or thrill seeking. We **can** do these things because: a) We are aware that these actions can improve our future health; and b) we have conscious free-will to make the choice to take a different path. When it comes to illnesses, such as hypercholesterolemia, diabetes, and cancer, we understand many of the mechanistic drivers of these diseases to a sufficient extent to enable the development of therapies to treat afflicted patients. We **can** be compassionate towards those that have been unlucky in the genetic lottery and be supportive as they do the extra work necessary to achieve the same life goals as genetically fortunate individuals. We **can**, and have changed our environment to reduce the risks associated with the spread

of communicable illnesses (for instance, installing hand sanitizing stations in public buildings, and development of annual flu vaccines). In fact, as a species, we have a track-record of using the scientific method to understand societal problems which are then followed by the implementation of widespread policy solutions. These solutions are effectively changes to our environment, which reduce risk-factors for undesired life outcomes for all of society.

Our current understanding of the specific pathologies leading to violent behaviors does not provide us with a list of “to-dos” or “not-to-dos” which could reduce the risk of becoming violent. As a society we need to support those doing the science to further our understanding and uncover the key drivers of violent behaviors. However, our current understanding of many of the risk-factors that pre-dispose us to violent and aggressive behavior highlights many environmentally derived conditions. Conditions like exposure to adverse childhood experiences, traumatic brain injury, environmental toxins, violent media, and poor nutrition are within our realm of control. We are empowered to not only reduce exposure to these risk-factors, but how we respond following exposure of ourselves, our loved ones, and those in our communities to these environmental risk-factors. We can change the environment for those with identified risk-factors by building community support. In essence, knowledge is not just power, but empowering. The pinnacle of humanity is the ability to understand ourselves and our environment beyond our immediate needs, and to use this understanding to advance science, build ever-improved environments, to tackle the toughest problems of our society for everyone. This is what it is to be humane.

References

- ¹ J. Ntanasis-Stathopoulos, J. G. Tzanninis, A. Philippou, and M. Koutsilieris. Epigenetic regulation on gene expression induced by physical exercise. *J.Musculoskelet.Neuronal.Interact.* 13 (2):133-146, 2013.
- ² J. A. McKay and J. C. Mathers. Diet induced epigenetic changes and their implications for health. *Acta Physiol (Oxf).* 202 (2):103-118, 2011.
- ³ J. C. Mathers. Session 2: Personalised nutrition. Epigenomics: a basis for understanding individual differences? *Proc.Nutr.Soc.* 67 (4):390-394, 2008.

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