# THE CARNIVORE CONNECTION: DIETARY CARBOHYDRATE IN THE EVOLUTION OF NON-INSULIN-DEPENDENT DIABETES (NIDDM)

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Non-insulin-dependent diabetes (NIDDM) is one of the most common chronic conditions affecting the world's population. In the Pima Indians and Nauruans, the prevalence of NIDDM has reached epidemic proportions while in others, such as the Australian Aborigines, the prevalence is several fold higher that of non-Aboriginal Australians. In fact, the European population and their descendants in other parts of the world may be the only group which does not have a high predisposition to NIDDM. It is now recognised that the major underlying metabolic characteristic is insulin resistance which is genetically determined and precedes the onset of the disease (Gulli et al. 1992). Why the insulin-resistant genotype became more frequent in some populations than in others is not known. Westernisation is thought to be responsible for the dramatic increase in NIDDM this century but the specific factors involved are also unknown.

We postulate a critical role for the quantity and quality of dietary carbohydrate in the pathogenesis of NIDDM in populations undergoing rapid westernisation. Our hypothesis is that insulin resistance offered a survival advantage to Ice Age human beings who hunted large game and ate a low carbohydrate, high protein diet for much of the year. The survival advantage existed because insulin resistance resulted in better glucose homeostasis when protein was abundant but carbohydrate was limited. In insulin-sensitive individuals, plasma glucose levels gradually fall after protein ingestion because protein stimulates postprandial insulin secretion (Nutall et al. 1984). In fact, chronic feeding of a high protein, low carbohydrate diet results in ketosis and relative insulin resistance in order to increase the supply of precursors for gluconeogenesis (Phinney et al. 1983).

Greater degrees of insulin resistance in the liver or muscles determined by one or more genes would have also facilitated the preferential utilisation of glucose by the foetus and the mammary gland, thereby providing a reproductive advantage. Hence groups subjected to a low carbohydrate diet for tens of thousands of years would display higher frequencies of the gene(s) controlling insulin resistance than would their counterparts who ate a high carbohydrate diet. Modern western diets, however, require an insulin-sensitive metabolism because of the abundance of carbohydrate which is quickly digested and absorbed. Individuals with in-born insulin resistance are at a disadvantage in the new environment because the β-cells need to secrete abnormally large amounts of insulin to overcome the insulin resistance. Individuals who cannot sustain the high insulin output eventually develop NIDDM.

Our 'carnivore' genotype hypothesis contrasts with the 'thrifty' genotype hypothesis which postulates that cycles of feast and famine during human evolution selected for a genotype which facilitated accumulation of body fat in times of food abundance. However, the ability to spare glucose metabolism during food scarcity via in-born insulin resistance rather than large stores of body fat, would have been a greater aid to survival. Indeed, the cold climate during Ice Ages may have been the major selection factor for individuals with extra body fat. The 'carnivore' hypothesis is supported by numerous observations and studies in animals and humans.

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