Part 1: A Chaos and Systems Perspective on the Cardiometabolic Pandemic

Cardiometabolic risk factors of obesity (especially central/waistline), hyperglycemia, hypertension, insulin resistance, and dyslipoproteinemia coupled with lifestyle factors including sedentary behavior and/or smoking predispose individuals to type 2 diabetes, metabolic syndrome, cardiovascular disease, and stack of other medical issues (AmeriHealth HMO Inc., 2009). Despite decades of advising the public to exercise more and "eat sensibly", the cardiometabolic pandemic has spread from the Western world to the far reaches of sub-Saharan Africa (Riha et al., 2014).

On the individual level, the causal approach to a solution has centered around the equation of energy balance where total energy = energy intake + energy expended where a balance of zero equates to status quo, maintenance; a positive balance equates to weight gain; a negative balance equates to weight loss (Flatt, 2012; Wells, 2013). "Excess energy intake (positive energy balance) causes weight gain" is logical but conceptually linear, uni-dimensional, assuming energy intake and energy expenditure are equivalent roles (Flatt, 2012). While there may be individual successes and failures, the causal approach has failed on a world-population scale.

Expanding from a causal to a relational approach takes into consideration the individual's behavioral and psychological readiness to change (transtheoretical model) along with complex matrices of factors that contribute to the individual's success in weight and diet management. These factors include social circles, religion, education, politics, leadership/responsibility roles the individual holds, personality, stress/pressure, work environment, neighborhood of residence, and several other environmental conditions. Unfortunately, even the relational perspective has failed on a world-population scale.

Using a systems approach, Fallah-Fini, Rahmandad, Huang, Bures, and Glass (2014) describe an energy imbalance gap (EIG) as the average daily excess energy intake (total daily intake - total energy expenditure) for some unit of time. The maintenance energy gap (MEG), likewise, is the increased energy intake needed to upkeep higher average body weights compared with the initial distribution of population body weight, say back in the 1970s (Fallah-Fini et al., 2014). This concept of MEG is what is needed to reverse the obesity pandemic over the population. Fallah-Fini et al. (2014) examined the concept of population energy intake and population energy expenditure so as to present a more global-scale perspective.

I would extend Fallah-Fini's et al. (2014) systems model, and suggest that obesity and the cardiometabolic pandemic might be studied using a dynamical systems and/or chaos theory perspective. Complex systems (e.g. education, technology/engineering advancement, urbanization, farming, ecology/environment, politics, religion, economics, disparity between affluence and poverty, cultural changes/modernization, power struggle dynamics) interact with each other and drive this pandemic.

The educational system has moved away from incorporating practical skills and home economics--life skills (Popkin, Adair, & Ng, 2012). Many students cannot manage money, and

many students cannot cook adequately and end up relying on deli services, frozen meals, restaurants, and fast-food (Popkin et al., 2012).

Urbanization and technology are systems that provide convenience, but convenience is a double-edged sword. Convenience often has an inverse relationship to physical activity, manual labor/effort, and the healthfulness of food choices (Hojjat, 2015; Popkin et al., 2012). Urbanization and technology have affected our ecological systems, farming, and food systems. While engineering crop such as those that produce oilseeds have created cheap vegetable oils, the same act has compromised crop genetics that have unknown long-term effects (Popkin et al., 2012). Cheap vegetable oils and edible oils have shifted the supply and demand for certain types of food, and people's affinity for the "taste" of certain types of food (Hojjat, 2015; Popkin et al., 2012). The same is true for non-caloric and caloric sweeteners made more available via technology and urbanization (Popkin et al., 2012).

Urbanization, technology, and economics affect our food systems. The fresh market (open public market) is disappearing and society is dominated by modern super and mega markets where processed and packaged food are more abundant than fresh and whole foods (Popkin et al., 2012). The availability of food choices is governed by supply, demand, and the profit margin. World trade and international economics affect the food supply chain (e.g. oil and sugar commodities) (Popkin et al., 2012).

Food deserts have been created by socioeconomical systems. The distance to a food market and the quality of food available at the food store contribute to the problem of obesity (Ghosh-Dastidar et al., 2014). Ghosh-Dastidar et al. (2014) noted that low-income residents often shopped outside their neighborhoods, and store choices (and store inventory and advertising) may well reflect the local economic demographic. Ghosh-Dastidar et al. (2014) also noted that store prices seemed to be inversely related to obesity.

Social systems (social circles including friends, family, and coworkers) influence obesity. Cultural systems influence obesity. Psychological factors influence obesity. Political systems and power also influence obesity, as well as entertainment and marketing. Obesity and disease are influenced by environmental factors from conception to adulthood (Popkin et al., 2012). Higher rates of obesity were found in indviduals whose mother were exposed to the Dutch famine during their pregnancy (Popkin et al., 2012). Hmong refugee immigrants who were raised in the war zone displayed higher rates of obesity, and generally children whose mother experienced a "resource-poor" environment (e.g. nutritional deficiencies and/or restriction) tend toward obesity or over-weight (Popkin et al., 2012).

The obesity problem seems to be an expression of all these factors, and perhaps a dynamical systems model (or chaos theory model) may offer new insight. Dynamical systems are nonlinear, and are dependent on past and present influences/events; its future state is not random but is determined by constraints. Dynamical systems have preferred "nodes" or behavioral "states" that over time, systems tend to be attracted to different "nodes of stability". Perhaps enough change in the factors contributing to the obesity problem, will cause a migration towards a new stable state, hopefully a step towards a solution.

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