Dynamical Systems Approach to the Obesity Pandemic

The causal approach to remedy the obesity pandemic centers 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). General recommendations for weight loss/management include energy intake restriction plus regular exercise consisting of cardiovascular endurance and resistance training ideally with varying intensity levels, duration, and volume (Volek, Quann, & Forsythe, 2010). The problem is that there is no cookie-cutter diet that works for everyone, and dietary recommendations must be tailored to the individual based on their current health status and nutritional deficiencies. Macro- and micronutrient ratios differ at different periods in time per individual, and hence, the individual's needs will vary as well as their responsiveness to the dietary and exercise prescription.

However, generally accepted recommendations support supplementation (at least general purpose multivitamin), as a host of micronutrients seem to be deficient no matter what diet one follows (Gardner et al., 2010). Also, a lower-available carbohydrate diet seems to be more conducive to overall health and weight-loss as opposed to a lower-available fat diet (Volek et al., 2010). Other recommendations support a Mediterranean-style diet; avoiding excessive intake of dietary fat; substituting saturated and trans fatty acids with monounsaturated and polyunsaturated n-3 and n-6 fatty acids; and getting adequate fiber (Weickert, 2012).

The causal approach to obesity, 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). Research in nutrition (e.g. macronutrients and micronutrients, and their metabolism), obesity, and overall health/wellness/fitness have uncovered matrices of relationships. Obesity, metabolic syndrome (MetS), and heart disease are related and share risk factors (Hansen, Dendale, van Loon, & Meeusen, 2010). Macro- and micro nutrients and metabolites affect each other, and the healthy function of a body, lipogenesis, and lipolysis depend on the balance of their complex relationships (Gardner et al., 2010; Volek, 2010; Wells, 2013). Nutrition affects sleep and stress which in turn affect weight (Wells, 2013).

Both the causal and relational models of the obesity problem are logical and reasonable. However, obesity is still on the rise. Several other interrelated systems impact the obesity issue.

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.

References

Flatt, J. P. (2012). Misconceptions in body weight regulation: Implications for the obesity pandemic. *Critical Reviews In Clinical Laboratory Sciences*, *49*(4), 150-165. doi:10.3109/10408363.2012.712904

Gardner, C. D., Kim, S., Bersamin, A., Dopler-Nelson, M., Otten, J., Oelrich, B., & Cherin, R. (2010). Micronutrient quality of weight-loss diets that focus on macronutrients: Results from the A to Z study. *The American Journal of Clinical Nutrition, 92,* 304-312.

Ghosh-Dastidar, B., Cohen, D., Hunter, G., Zenk, S. N., Huang, C., Beckman, R., & Dubowitz, T. (2014). Distance to store, food prices, and obesity in urban food deserts. *American Journal Of Preventive Medicine*, *47*(5), 587-595. doi:10.1016/j.amepre.2014.07.005

Hansen, D., Dendale, P., van Loon, L. C., & Meeusen, R. (2010). The impact of training modalities on the clinical benefits of exercise intervention in patients with cardiovascular disease risk or type 2 diabetes mellitus. *Sports Medicine*, *40*(11), 921-940.

Hojjat, T. A. (2015). The economic analysis of obesity. *Review Of Business & Finance Studies*, *6*(1), 81-98.

Popkin, B. M., Adair, L. S., & Ng, S. W. (2012). Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition Reviews*, *70*(1), 3-21.

Volek, J. S., Quann, E. E., & Forsythe, C. E. (2010). Low-carbohydrate diets promote a more favorable body composition than low-fat diets. *Strength and Conditioning Journal*, *32*(1), 42-47.

Weickert, M. O. (2012). What dietary modification best improves insulin sensitivity and why?. *Clinical Endocrinology*, *77*(4), 508-512. doi:10.1111/j.1365-2265.2012.04450.x

Wells, J. K. (2013). Obesity as malnutrition: the dimensions beyond energy balance. *European Journal Of Clinical Nutrition*, *67*(5), 507-512. doi:10.1038/ejcn.2013.31