Podcast Episode 21: Calorie Restriction

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Episode teaser

Hey everyone! Welcome to the new episode of the Life Extension Podcast – technology & magic, society & business. In this episode I will present calorie restriction as a method to live longer. Calorie restriction is currently the only method of life extension, on which all gerontologists agree that it works. You might want to listen to this episode to hear about the benefits and challenges of this practice, as well as about the underlying science. This will lead you into a discussion of illness, science and culture.

What is calorie restriction

When checking the literature about calorie restriction, you would find numerous publications, some of them with "secret" or "diet" in their title. Others, the more serious ones, describe the effects of calorie restriction on delaying the onset of age-related disease conditions and longer life spans. These effects are demonstrated partly through trials involving various species of living organisms, as well as through mechanistic pathways at the level of molecular biology, and a variety of biological markers for aging, equally at molecular and DNA level. Now, is there really a difference between calory restriction and the many other dietary regimes applied by overweight people? In my opinion, the short answer is "no", except that the calorie restriction method is subject to serious scientific investigations. For the first time scientists try to understand the exact biochemical reasons underlying the relationship between the amount of energy we consume and aging.

Trials:

From circumstantial observation we suspect that moderate and healthy eating habits are beneficial for health. People feeding mostly on fast food and soft drinks tend to be more overweight and less healthy than people preferring Mediterranean or Japanese eating habits. On the other hand, we also observe that starvation is detrimental to health, as it leads to an important deficit in our energy balance and an insufficient supply of micronutrients. The practice called calorie restriction is defined by a long-term, moderate reduction of 20 to 40% of energy intake compared to what we would normally eat, while at the same time supplementing lacking micronutrients like vitamins and minerals.

Observational trials have consistently confirmed positive effects of calorie restriction on aging, mainly regarding the onset of age-related disease conditions, but also with regards to all kind of physiological markers associated to aging. During 2 years of the biosphere II experiment in the 1990s, which involved human participants living in controlled facilities sealed off from the environment, participants have practiced calory restriction and have all lost weight and improved their physiological aging markers during the experiment (Walford 1995). Other groups of people practicing calory restriction as a lifestyle consistently confirm the same results. Nevertheless, such trials are merely observational, and scientific

interest in the underlying causes of aging have led to the requirements of more rigorous trials relating nutrition to aging.

Experiments with mice (Faulks 2006) and rats, worms and flies in laboratory trial settings have all demonstrated that a relationship between energy input and health, sometimes longevity clearly exists. In most cases calorie restriction would lead to an improvement of health, as well as higher average and maximum life spans.

Two independent trials with monkeys were started more than 30 years ago and are ongoing with a few individuals still alive (Flanagan 2020). Results of both trials support the argument that lower food intake in adulthood is associated with improved survival in nonhuman primates. Several individuals have even lived beyond the maximum life span ever recorded for this species (Mattison 2017).

A large human trial called CALERIE lasted for two years and was completed in 2010. At the end of the trial participants in the calorie restriction group showed a reduction in a wide range of risk factors for age-related diseases and inflammatory markers, all being related to longer life span. Compared to the control group they also lost weight, most of it being body fat. And no adverse effects were found (Flanagan 2020, NIA)

Benefits:

Scientists are able to measure effects on chronological age only in trials with short-lived organisms. In the case of rhesus monkeys, which live 30 to even more than 40 years, they already went to extraordinary length to keep the experiment ongoing for such a long time until all trial participants die of old age. For trials with humans that would be impossible. Instead of measuring chronological age resulting from calorie restriction scientists measure other parameters: next to the most obvious method of measuring weight and body-mass-index, there are numerous other physiological markers with regards to energy metabolism, oxidative stress, and inflammation status. Risk factors for developing all kind of age-related disease conditions can be determined. DNA methylation patterns are used by epigenetic clocks to determine changes in biological age compared to chronological age, as I have discussed in a previous episode. Furthermore, a number of molecular pathways related to the aging process in cells have been hypothesized. All these measurements are affected positively after calorie restriction. The results of all trials involving animal organisms incl humans are consistently confirming that calorie restriction leads to an improvement of health, a delay in the onset of age-related disease conditions, as well as an extension of average and sometimes maximum life spans (Flanagan 2020, Chung 2020). But not only age-related diseases like cardiovascular conditions or diabetes are positively affected. The same is generally true for cancer. There is a clear relationship between being overweight and the occurrence of cancer. In the US, which has a bigger problem with unhealthy eating habits than most, two third of American adults are considered overweight as a result of sedentary lifestyle, eating too much, and exercising too little (McTiernan et al 2012).

Increasing prosperity in many countries has been linked to a progressive rise in food intake, often leading to people becoming overweight or obese, accompanied by an early onset of age-related diseases and shorter life spans (Everitt et al 2010). Rising prosperity with the freedom to eat as much as

we want seems first to lead to an increase in life spans, but risks to decrease life span after some time, if the entire population, or important sub-groups adopt the wrong eating habits. This seems to be the case most obviously in the US, where average life expectancy has started to drop.

Concerns about calorie restriction

A few concerns are voiced regarding perceived risks of calorie restriction, but all have been disproven. In popular imagination, a big body would be stronger than a lean body and would serve to protect health in adverse situations like when in hospital or in old age. That is wrong. During calorie restriction trials a reduction of bone density has been noticed, however usually not more than was to be expected in relation to weight loss. Also being big is not equivalent to being strong. During the trials the majority of weight loss was accounted for by a reduction of fat mass, not muscle mass. Of course, any reduction of muscle mass could lead to the conditions of sarcopenia and frailty in old age. But this concern is countered by other research results that calorie restriction induces molecular adaptations which slow down sarcopenia (Flanagan 2020:120). Furthermore, the most important factor against a reduction in muscle mass and strength is physical exercise, not nutrition (Flanagan 2020). Another concern about calorie restriction is sexual and mental health. However a reduction in sexual drive and an onset of depression appeared only during starvation trials (Keys 1950). In the contrary calorie restriction in the CALERIE experiment seems to have led to improvements of sex drive and mental health for a few participants (Flanagan 2020).

Calorie restriction sounds like a great method to delay aging and increase longevity. However there is a serious flaw in this perspective. The flaw is in the control group, or rather in what is considered as normal or standard eating habits. Participants in animal control groups are either allowed to eat as much as they like, or participants are selected based on a body weight considered as standard in societies where the majority of people eats too much. This means that participants in control groups are most likely to take in more energy than they expend, which leads to a shortened life span. In that case calorie restriction is not beneficial in itself, but would just compensate the negative effects of eating too much. So if live span in the control group is short due to a persistent energy surplus, the life extension effect of calorie restriction would appear more pronounced, and vice versa (Sohal+Forster 2014) (Note).

Most of calorie restriction trials mentioned in this episode were conducted in the US, probably because that country has a particular problem with unhealthy eating habits. And as mentioned, the definition of a standard diet or body mass of control group participants may be very different from standards defined at the scale of human evolution, when seasonal hunger was part of life, or even in other societies. Under the premises that abundant food is available, we can still observe a wide variety of types and quantities of food that people regularly consume. Even within the same society, different social groups follow very different nutrition patterns. Those differences are not the result of biology, but of psychology and culture.

Conclusion: The problem is cultural

National medical agencies, like the NIH in the US commit themselves to research of nutrition-based approaches to improve health. Important funding from public and private sources is available to finance understanding of mechanistic cellular pathways, relating eating habits to health and life span, all this feeding into drug development and self-aid books. Wide and detailed research efforts are undertaken. But they mostly remain incomprehensible to the non-scientist. Worse, by having to learn biochemistry to understand obesity, we risk losing ourselves in overwhelming complexity.

One may be forgiven to be puzzled. Bad eating habits at the level of a population are induced by culture, social structure, and the food industry. But instead of addressing these issues heads-on, social institutions like the NIH are medicalizing the problem. Instead of asking people to discontinue an unhealthy habit, society is prescribing a treatment. Maybe being over-weight is a mental disease. But who is sick – the individual or the culture? From an anthropological point of view, mental illness is mostly not the result of biology, but of culture. Mental diseases are identified first by negotiation between patient and medical practitioner, be that a psychologist, a shaman, or any other healer (Kleinman 1981). A disease needs to be named to be treatable. In the technoscientific age in which we live, that name will of course be formulated in terms of modern science. As a result society is nowadays trying to define obesity in terms of molecular pathways in cell metabolism, instead of Freudian repression, an imbalance in vital body fluids, or the evil eye of the witch next door. In this way calorie restriction has become structured as modern medical therapy, although it is actually just the correction of an unhealthy behavior.

The difficulty to eat less does not just relate to the individual but to society. If someone belongs to a culture or social class, where people eat healthily, one is more likely to express the same behavior – and vice versa. The solution to bad health and shorter life span as the result to bad eating habits is not science, but either to change lifestyle, or to move to a different cultural environment. The real problem is cultural, not insufficient science.

Note:
"…. it can also be argued that CR does not increase longevity per se: rather the AL feeding shortens the life span, because it causes a deleterious energy imbalance, which prevents the animals from reaching their potential longevity. The salutary effect of CR on life span mirrors the negative effect of AL feeding. Accordingly, the longevity prolongation effect of CR should be relatively greater if the life spans of the controls become shorter owing to energy imbalance." (Sohal+Forster 2014).

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