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The effect on health of alternate day calorie restriction: Eating less and more than needed on alternate days prolongs life

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Summary Restricting caloric intake to 60–70% of normal adult weight maintenance requirement prolongs lifespan 30–50% and confers near perfect health across a broad range of species. Every other day feeding produces similar effects in rodents, and profound beneficial physiologic changes have been demonstrated in the absence of weight loss in ob/ob mice. Since May 2003 we have experimented with alternate day calorie restriction, one day consuming 20–50% of estimated daily caloric requirement and the next day ad lib eating, and have observed health benefits starting in as little as two weeks, in insulin resistance, asthma, seasonal allergies, infectious diseases of viral, bacterial and fungal origin (viral URI, recurrent bacterial tonsillitis, chronic sinusitis, periodontal disease), autoimmune disorder (rheumatoid arthritis), osteoarthritis, symptoms due to CNS inflammatory lesions (Tourette's, Meniere's) cardiac arrhythmias (PVCs, atrial fibrillation), menopause related hot flashes. We hypothesize that other many conditions would be delayed, prevented or improved, including Alzheimer's, Parkinson's, multiple sclerosis, brain injury due to thrombotic stroke atherosclerosis, NIDDM, congestive heart failure.

Our hypothesis is supported by an article from 1957 in the Spanish medical literature which due to a translation error has been construed by several authors to be the only existing example of calorie restriction with good nutrition. We contend for reasons cited that there was no reduction in calories overall, but that the subjects were eating, on alternate days, either 900 calories or 2300 calories, averaging 1600, and that body weight was maintained. Thus they consumed either 56% or 144% of daily caloric requirement. The subjects were in a residence for old people, and all were in perfect health and over 65. Over three years, there were 6 deaths among 60 study subjects and 13 deaths among 60 ad lib-fed controls, non-significant difference. Study subjects were in hospital 123 days, controls 219, highly significant difference. We believe widespread use of this pattern of eating could impact influenza epidemics and other communicable diseases by improving resistance to infection. In addition to the health effects, this pattern of eating has proven to be a good method of weight control, and we are continuing to study the process in conjunction with the NIH.
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It is well established that by reducing the number of calories required for weight maintenance to 60—70% of normal, lifespan is increased up to 40%, with near perfect health across a broad range of species.

Application of this calorie restriction (CR) principle to humans would be of enormous value, but such severe restriction makes compliance impossible on a daily basis. Many animal studies of intermittent feeding (24 feeding, 24 h only water) have demonstrated health-promoting physiological changes. Recently in Lancet, Mattson [1] wrote an editorial to encourage increased study of the effect of (reduced) meal frequency on health. For two years we have experimented with an alternate day pattern of eating in which intake is limited to 20—50% of estimated daily requirement one day followed by ad lib eating the next day. This alternate day calorie restriction appears to have health-promoting effects in the absence of weight loss.

In support of our hypothesis is our re-interpretation of a study in the medical literature.

Several leading authors have cited a study by Eduardo Arias Vallejo [2][1] published in 1956 in the Spanish journal Revista Clinica Espanola as the only example in the medical literature of calorie restriction in humans in which good nutrition was practiced [1—6].

After examining the original Spanish article, we believe that there was no calorie reduction, but that there was a pattern of eating in which on alternating days subjects ate less and more than their daily caloric requirement.

The study was carried out in an old age home run by a religious order (St. Joseph) in Madrid over a three year period on a population of 120 men and women ''in perfect health'' over the age of 65. Sixty treatment subjects were fed on odd days of the month a diet containing 2300 calories with 50 g of protein and 40 g of fat. On even days, they were given one liter of whole milk and 500 g of fresh fruit (about 900 calories). Literally translating from Spanish, the 60 controls were fed ''the first diet'' (''la primera dieta'') , referring to the diet which was described first in the text (2300 calorie with 50 g protein and 40 g of fat). Stunkard analyzed the Vallejo article in 1976 and stated that the control group was fed 2300 calories per day. No such statement appears in the original article and Stunkard's mis-translation led subsequent authors who relied on his description to incorrect and impossible conclusions. We believe what Vallejo meant by ''the first diet'' was ''ad lib consumption of the standard institutional diet in the nursing home'', but *not* 2300 calories per day, as discussed below.

There was a highly statistically significant difference in number of days in the infirmary (123 treatment group, 219 for controls, $p < .001$) but non-significant difference in deaths (treatment 6, controls 13). Vallejo and other authors conclude that the study suggests the regime employed might prolong lifespan in the elderly.

The error in previous analyses is in estimating daily calorie requirements. We were unable to find data for calorie consumption in people over 65 in Spain in the mid-1950s, but an estimate of daily calorie requirement can be made by using the average of male and female body weight and height among Spaniards in the 1960s, age 20—49 (Eveleth and Tanner, *Worldwide variation in human growth*, 1976, pages 33, 34, 285, 287, Ref. [9]). Applying the Harris Benedict formula for calculating calorie consumption and assuming an inactive lifestyle, the figure calculated for the younger age group is 1600 calories per day, and may have been slightly lower for these elderly people.

Various authors have stated that there was a 35% calorie deficit in the experimental group [4,5,7] By this reckoning each subject would have lost an average of more than 38 kg in the first year of the study. It is difficult to imagine that the subjects, their families, Dr. Vallejo or the St. Joseph nuns would have permitted significant weight loss in these elderly subjects. Further, there is no mention in the article of calorie restriction or synonyms or weight loss among the subjects, and the two tables in the article label the two groups as ''dias alternos''(alternate days) and ''dieta normal''(normal diet) strongly suggesting the control group was simply fed ad lib the institutional food.

It is inconceivable that the controls were eating an average of 2300 calories daily, at least 44% more than daily requirement by our method of estimation.

Adding the daily intake of 900 and 2300 and dividing by 2 yields 1600 calories per day, equal to our estimated daily requirement for this group of elderly people.

Thus it appears the treatment subjects were either consuming 700 calories less (900) or 700 calories more (2300) than the daily requirement of 1600 calories on the two days. This study is therefore not a study of ''caloric restriction'' but instead is a study of an up and down pattern of consumption with no change in body weight.

[1] Dr. Arias Vallejo published over 200 professional articles and served as president of the Spanish Society of Digestive Pathology.

On the fruit/milk day, the actual calorie intake as a function of daily requirement, (900 divided by 1600) is 56% of daily requirement. Based on our anecdotal experience, compliance with an alternate day restriction of this degree is not difficult for a motivated individual to follow.

Recent animal evidence [10] suggests that body weight or body fat content may be unrelated to health-promoting physiologic changes (improved glucose metabolism and neuronal resistance to injury) seen with intermittent fasting (24 h of ad lib feeding followed by 24 h of only water).

We have had anecdotal experience with over 500 subjects for up to 2.5 years following a repeating pattern of ad lib eating one day followed by 20—50% of daily estimated calorie requirement the next day. We have observed improvement in a variety of disease conditions, starting within 2 weeks, including insulin resistance, asthma, seasonal allergies, autoimmune disease (rheumatoid arthritis), osteoarthritis, infectious disease of viral, bacterial, and fungal origin(toenail fungus, periodontal disease, viral URIs)inflammatory central nervous system lesions (Tourette's syndrome, Meniere's disease) and cardiac arrhythmias (frequent extrasystoles, atrial fibrillation), menopause related hot flashes.

Based on a broad range of calorie restriction studies in animals in which virtually all diseases are delayed, prevented or ameliorated by calorie restriction, *we propose that this dietary pattern, with or without weight loss, will delay, prevent or improve a wide variety of human diseases* in addition to the above, including multiple sclerosis, Alzheimer's disease, Parkinson's disease, atherosclerosis, NIDDM, congestive heart failure, and resistance to brain injury from thrombotic stroke.

Clearly, if our interpretation of the Vallejo study and our anecdotal observations are correct, the implications for improved human health are enormous if this pattern of eating were widely adopted. Aside from individual health, widespread use could alter patterns of epidemics such as influenza because of resistance to infection imparted by the calorie restriction mechanism presumably activated by the intermittent pattern of consumption.

We have also found this pattern of eating to lend itself to weight control. It allows the subject to eat normally every other day and thus avoid the endless horizon of deprivation chronic dieters envision. It is our observation that this alternating day pattern of calorie intake makes this method feasible for weight control while simultaneously conferring improvement in all aspects of health.

In collaboration with Mark Mattson, PhD, Chief, Neurosciences Laboratory, Gerontology Research Center, National Institute of Aging, National Institutes of Health, we are nearing completion of a manuscript describing an IRB approved 8 week pilot study of the effect of following a repeating pattern of eating ad lib one day and 20% of daily caloric requirement the next day on subjects with moderate persistent asthma. Preliminary results show highly significant improvement in parameters of pulmonary function and markers of inflammation and oxidative damage and will be submitted to a peer-reviewed medical journal.

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